Sandia National Laboratories / New Mexico

PROPOSAL FOR NO FURTHER ACTION
ENVIRONMENTAL RESTORATION PROJECT
SITE 234, STORM DRAIN SYSTEM OUTFALL SITE
OPERABLE UNIT 1309

June 1995

**Environmental
Restoration
Project**

**United States Department of Energy
Albuquerque Operations Office**

PROPOSAL FOR NO FURTHER ACTION

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SANDIA NATIONAL LABORATORIES/NEW MEXICO

1. Introduction

1.1 ER Site Identification Number and Name

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a risk-based no further action (NFA) decision for Environmental Restoration (ER) Site 234, Storm Drain System Outfall Site, Operable Unit (OU) 1309. ER Site 234 is listed in the Hazardous and Solid Waste Amendment (HSWA) Module IV (EPA August 1993) of the SNL/NM Resource Conservation and Recovery Act (RCRA) Hazardous Waste Management Facility Permit (NM5890110518) (EPA August 1992).

1.2 SNL/NM Risk-Based NFA Process

This proposal for a determination of an NFA decision has been prepared using the criteria presented in Section 4.5.3 of the SNL/NM Program Implementation Plan (PIP) (SNL/NM February 1994). Specifically, this proposal will "contain information demonstrating that this SWMU has never contained constituents of concern that may pose a threat to human health or the environment" [as proposed in the Code of Federal Regulations (CFR), Section 40 Part 264.51(a) (2)] (EPA July 1990). The HSWA Module IV contains the same requirements for an NFA demonstration:

> Based on the results of the RFI [RCRA Facility Investigation] and other relevant information, the Permittee may submit an application to the Administrative Authority for a Class III permit modification under 40 CFR 270.42(c) to terminate the RFI/CMS [corrective measures study] process for a specific unit. This permit modification application must contain information demonstrating that there are no releases of hazardous waste including hazardous constituents from a particular SWMU at the facility that pose threats to human health and/or the environment, as well as additional information required in 40 CFR 270.42(c) (EPA August 1993).

For a risk-based proposal, an SWMU is eligible for an NFA determination if the NFA criterion established by the SNL/NM permit is met. This criterion, found in Section M.1 of the permit, is as follows: "[T]here are no releases of hazardous waste including hazardous constituents...that pose threats to human health and/or the environment..." This risk-base proposal contains information needed to make the NFA determination.

This proposal is using the technical approach which is the foundation for the SNL/NM corrective action process. The details of the SNL/NM technical approach are provided in Appendix C of the PIP. The first step in the technical approach is the data qualitative review step (the same step used to determine whether the SWMU is eligible for administrative NFA). Should significant uncertainties remain, the assessment of the SWMU continues within the SNL/NM technical approach.

At this site, sufficient data were not available to compare to established action levels or develop site-specific action levels. Background soil samples were collected and analyzed to develop upper tolerance limits (UTLs) for metals. Site-specific data were collected to compare to existing soil action levels (proposed Subpart S action levels) and UTLs. If site-specific concentrations exceeded the proposed Subpart S action levels or UTLs, then a risk assessment was performed. The site-specific concentrations were compared to the derived risk assessment action levels. Concentrations less than these action levels, either proposed Subpart S action levels, UTLs, or derived risk-based values, triggered this NFA proposal for Site 234.

1.3 Local Setting

SNL/NM occupies 2,829 acres of land owned by the Department of Energy (DOE), with an additional 14,920 acres of land provided by land-use permits with Kirtland Air Force Base (KAFB), the United States Forest Service, the State of New Mexico, and the Isleta Indian Reservation. SNL/NM has been involved in nuclear weapons research, component development, assembly, testing, and other nuclear activities since 1945.

ER Site 234 (Figure 1) is located on land owned by DOE. The outfall is located along the northern embankment of Tijeras Arroyo southeast of Building 981I (Inflatable Building) and a lagoon impoundment in Technical Area (TA) IV.

Surficial deposits in the SNL/KAFB area lie within four geomorphic provinces which in turn contain nine geomorphic subprovinces. Site 234 lies within the Tijeras Arroyo subprovince. The Tijeras Arroyo subprovince is characterized by broad, west-sloping alluvial surfaces and the 50-meter-deep Tijeras Arroyo. The Tijeras Arroyo subprovince contains deposits derived from many sources, including granitic and sedimentary rocks of the Sandia Mountains, sedimentary and metamorphic rocks of the Manzanita Mountains, and sediments of the Upper Santa Fe Group.

2. History of the SWMU

2.1 Sources of Supporting Information

In support of the request for a risk-based with confirmatory sampling NFA decision for ER Site 234, a background study was conducted to collect available and relevant site information. Interviews were conducted with SNL/NM staff and contractors familiar with site operational history.

The following information sources were available for the use in the evaluation of ER Site 234:

- Confirmatory sampling program conducted in September 1994
- Risk analysis for two radionuclides
- One surface radiation survey
- One unexploded ordnance/high explosives (UXO/HE) survey
- Interviews and personnel correspondence
- Historical aerial photographs spanning 40 years
- Personal breathing zone air sampling

2.2 Previous Audits, Inspections, and Findings

In November 1993, the Sandia ER staff recognized Site 234 as an SWMU. ER Site 234 was not listed as a potential release site based on the Comprehensive Environmental Assessment and Response Program (CEARP) interviews in 1985 (DOE September 1987). In addition, Site 234 was not included in the Environmental Protection Agency (EPA) RCRA Facility Assessment (RFA) in 1987 (EPA April 1987) and Site 234 was not included in the Hazard Ranking System (DOE September 1987).

2.3 Historical Operations

The outfall discharged industrial effluent and storm water from TA-IV (Figure 1). Currently, the outfall discharges only storm water. The specific constituents in the industrial effluent are not known. The possible discharge contaminants include chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, and other petroleum products. Mineral oil is also considered a potential soil contaminant because of a recent release (June 1994) of mineral oil at a similar outfall, Site 232.

3. Evaluation of Relevant Evidence

3.1 Unit Characteristics

The Storm Drain System Outfall is confined to the downstream natural drainage. All releases would be contained in this restricted area.

3.2 Operating Practices

Based on interviews and personnel correspondence, the outfall discharged industrial effluent and storm water from approximately 1978 to 1991. Examination of aerial photographs confirms this time frame but provides no additional information.

3.3 Presence or Absence of Visual Evidence

The approximately 250-foot long outfall and the cement culvert are the only physical evidence of the outfall system. No discoloration of soils was observed during site reconnaissance and soil sampling activities.

3.4 Results of Previous Sampling/Surveys

In 1994, the site was visually surveyed for surface indications of unexploded ordnance and UXO/HE. No UXO/HE were found (SNL/NM 1994a). Also in 1994, a surface radiation survey was conducted on the entire site using an Eberline ESP-2 portable scaler, with an Eberline SPA-8 (2 inch X 2 inch sodium iodide) detector. A 30-second integrated count was performed at each proposed sample location, while scanning the detector over an area approximately 2 feet in radius around the sample location. The alarm was set at 1.3 times the background count rate. No alarms occurred during the survey. No surface anomalies were detected (SNL/NM 1994b).

3.5 Assessment of Gaps in Information

No environmental sampling data existed for Site 234. If contamination was present, potential constituents of concern (metals, radioactive constituents, and organic constituents), would be expected at shallow depths. Metals and radioactive constituents generally adsorb on soil and precipitate rather than remaining soluble. If organic constituents were introduced in the drainage, they should be detectable in surface or shallow subsurface soils.

3.6 Confirmatory Sampling

A surface (0-6 inches deep) and shallow subsurface (6-36 inches deep) soil sampling program was developed and implemented in September 1994. The Confirmatory Sampling and Analysis Plan (SAP) can be found in Appendix A. Those soil sample results exceeding an action level are summarized in Table 1. A complete list of "hits" or detections and quality assurance (QA) results can be found in Appendix B.

For health and safety purposes, a photo-ionization detector, OVM, was used throughout the field program. The OVM measured no anomalous vapor concentrations.

Surface and shallow subsurface soil samples were collected at the most likely locations of contamination. The inlets to this site are uncontrolled. Two samples were collected at each of four inlets and four samples were collected at the furthest extent of visible erosion and scour (Figure 1). Every sample was analyzed for metals[1], chromium^{+6}, and total petroleum hydrocarbons (TPH). The six subsurface samples also were analyzed for volatile organic compounds (VOCs). Six samples were analyzed for semivolatile organic compounds (SVOCs). As a general check for radioactive constituents, two samples were analyzed for tritium, one sample was analyzed for isotopic uranium and plutonium, and four samples were screened with in-house gamma spectroscopy.

3.6.1 Background Samples for Metals and Radioactive Constituent

UTLs for background metals were calculated from analyses of 24 samples collected in the vicinity of the 11 sites discussed in the SAP (Appendix A). UTLs or background 95th percentiles for background radionuclides were calculated from samples collected throughout KAFB (IT 1994). A discussion of background calculations and supporting data and analyses are included in Appendices C and D.

[1] Although the targe analyte list (TAL) metal analytes include calcium, magnesium, potassium, and sodium, these nontoxic, major cations are not included in the evaluation. They do not pose a significant environmental or human health risk regardless of concentration.

3.6.2 *Organic Compounds*

No analyses yielded positive detections of organic compounds. All detections were qualified with a "J" (see Table 1), meaning detected below the reportable limit and most detections also were qualified with a "B," meaning detected in the associated blank. None of these qualified detections indicate significant contamination. No TPH was detected.

3.6.3 *Metals*

Personal breathing zone air sampling was performed to monitor airborne particulate contamination for metals at Site 234. No airborne metal contamination was detected. The maximum local background value for beryllium was 0.53 milligrams per kilogram (mg/kg). Beryllium was not detected above 0.53 mg/kg at Site 234. Mercury, selenium, silver, and chromium^{+6} were not detected in any site samples. No other metal samples had concentrations above the local background UTLs. Based on the soil sample data, metals pose an insignificant human health and environmental risk at Site 234.

3.6.4 *Radionuclides*

Thallium was not detected at Site 234. Plutonium-239/240, plutonium-238, and uranium-235/236 were not detected above the minimum detectable activity (MDA). Uranium-238 and uranium-234 were detected in Sample 234-01-A at 0.44 and 0.50 picocuries per gram (pCi/g), respectively; both were below the base-wide background 95th percentile of 1.1 and 1.0 pCi/g and below the maximum local background values of 0.84 and 0.97 pCi/g, respectively. Radium-226 was detected in Sample 234-01-A at 2.27 pCi/g compared to a base-wide background UTL of 1.94 pCi/g. Additional off-site radiological analyses for radium-226 indicated lower activities than 2.27 pCi/g. Tritium was detected in Samples 234-01-A and 234-05-A at 0.23 and 0.038 pCi/g, respectively.

3.6.5 *Quality Assurance Results*

As discussed in the Confirmatory Sampling and Analysis Plan (Appendix A), quality assurance samples, including field duplicates, trip blanks and rinsates, were collected as part of the 11-site sampling program. Analyses indicate that the field soil duplicates were comparable to the original soil sample results. The trip blanks and rinsates indicated no significant sampling contamination. QA results can be found in Appendix B. Level I and Level II data verification was conducted on all data, as described in the PIP (SNL/NM 1994).

3.7 Risk Analysis

To further evaluate the site data for radionuclides with activities above background UTLs (or 95th percentiles) or those without background UTLs, risk was analyzed for the combination of tritium and radium-226, assuming the maximum detected activities.

The risk calculations were designed to produce conservatively large estimates of radioactive dose to counter uncertainties in the soil data. This approach facilitates the following decision regarding future activities at Site 234:

- If the conservative estimates based on the soil data result in an unacceptable dose (greater than 10 mrem/year), further investigation and/or remediation will be needed; or

- If the dose estimates are acceptable, the potential for health hazards at the site is extremely low, and further actions will not be needed.

Radionuclide doses were computed using methods and equations promulgated in proposed RCRA Subpart S documentation (EPA 1990). Accordingly, all calculations were based on the assumption that receptor doses from radionuclides result from ingestion of contaminated soil.

Calculation of radionuclide doses required values of dose conversion factors, which are used to convert radionuclide intakes (in units of pCi/year) into effective dose equivalents (in units of mrem/year). Published values of dose conversion factors (Gilbert et al., 1989) exist for tritium and radium-226.

To assure that the computed doses were conservatively large, only the maximum observed activity of each constituent at a site was employed. To consider combined effects, a radiological dose was calculated as the sum of the individual doses.

Following proposed Subpart S methodology, the equation and parameter values used to calculate the summed radioactive dose were:

$$\text{DOSE} = \sum_i [\text{DSR(i)} \times \text{S(i)}] \tag{1}$$

where:

DOSE	=	total effective dose equivalent (mrem/yr);
DSR(I)	=	dose-to-soil concentration ratio for the i^{th} radionuclide (mrem/yr)/(pCi/g), = I X DCF(I);
S(I)	=	soil concentration of the i^{th} radionuclide (pCi/g);
I	=	soil ingestion rate = 0.2 g/day = 73 g/yr; and
DCF(I)	=	dose conversion factor for the i^{th} radionuclide (mrem/pCi).

The PIP stipulates that, for the purpose of computing media action levels, the total radioactive dose at a site should not be greater than 10 mrem/year (SNL/NM 1994), which corresponds to a cancer risk of less that 10^{-6} excess deaths.

The input and results of the risk calculations are presented in Table 2. The summed radioactive dose is less than 10 mrem/year. Therefore, the site is considered to be risk-free in terms of radionuclide contamination.

3.8 Rationale for Pursuing a Risk-based NFA Decision

Surface soil and shallow subsurface soil samples were collected at the uncontrolled inlets of the outfall and at the furthest extent of visible erosion/scour where the discharged effluent would have most likely settled. These areas are the most likely areas for contamination. SNL/NM is proposing a risk-based NFA because representative soil samples from ER Site 234 have concentrations less than action levels; either proposed Subpart S action levels, background UTLs, background 95th percentiles, or derived risk-based values.

In addition

- A site visit in 1993 by ER personnel confirmed the presence of a confined natural drainage with no discoloration in the soils.
- In June 1994, a UXO/HE visual survey was conducted by KAFB Explosives Ordnance Division (EOD) and found no UXO/HE ordnance debris at Site 234 (SNL/NM 1994a).
- In September, 1994, Personal Breathing zone air sampling was performed to monitor airborne particulate contamination for metals at Site 234. No airborne contamination was detected.
- In September, 1994, as part of the surface soil sampling effort at Site 234, a surface radiation survey was conducted (SNL/NM 1994b). No surface anomalies were detected at Site 234.

4. Conclusion

Based upon the evidence cited above, ER Site 234 has no releases of hazardous waste or hazardous constituents that pose a threat to human health and/or the environment. Therefore, ER Site 234 is recommended for an NFA determination.

5. References

5.1 ER Site References

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5.2 Reference Documents

Department of Energy (DOE), September 1987. "Comprehensive Environmental Assessment and Response Program, Phase I Installation Assessment Sandia National Laboratories - Albuquerque," Department of Energy Albuquerque Operations Office, Environmental Safety and Health Division, Environmental Program Branch, September 1987.

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U.S. Environmental Protection Agency (EPA), April 1987. "Final RCRA Facility Assessment Report of Solid Waste Management Units at Sandia National Laboratories, Albuquerque, New Mexico," Contract No. 68-01-7038, EPA Region VI.

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U.S. Environmental Protection Agency (EPA), August 1992. "Hazardous Waste Management Facility Permit No. NM5890110518, EPA Region VI," issued to Sandia National Laboratories, Albuquerque, New Mexico.

5.3 Aerial Photographs

Ebert & Associates, Inc., November 1994. "Photo-Interpretation and Digital Mapping of ER Sites 7,16,45,228 from Sequential Historical Aerial Photographs."

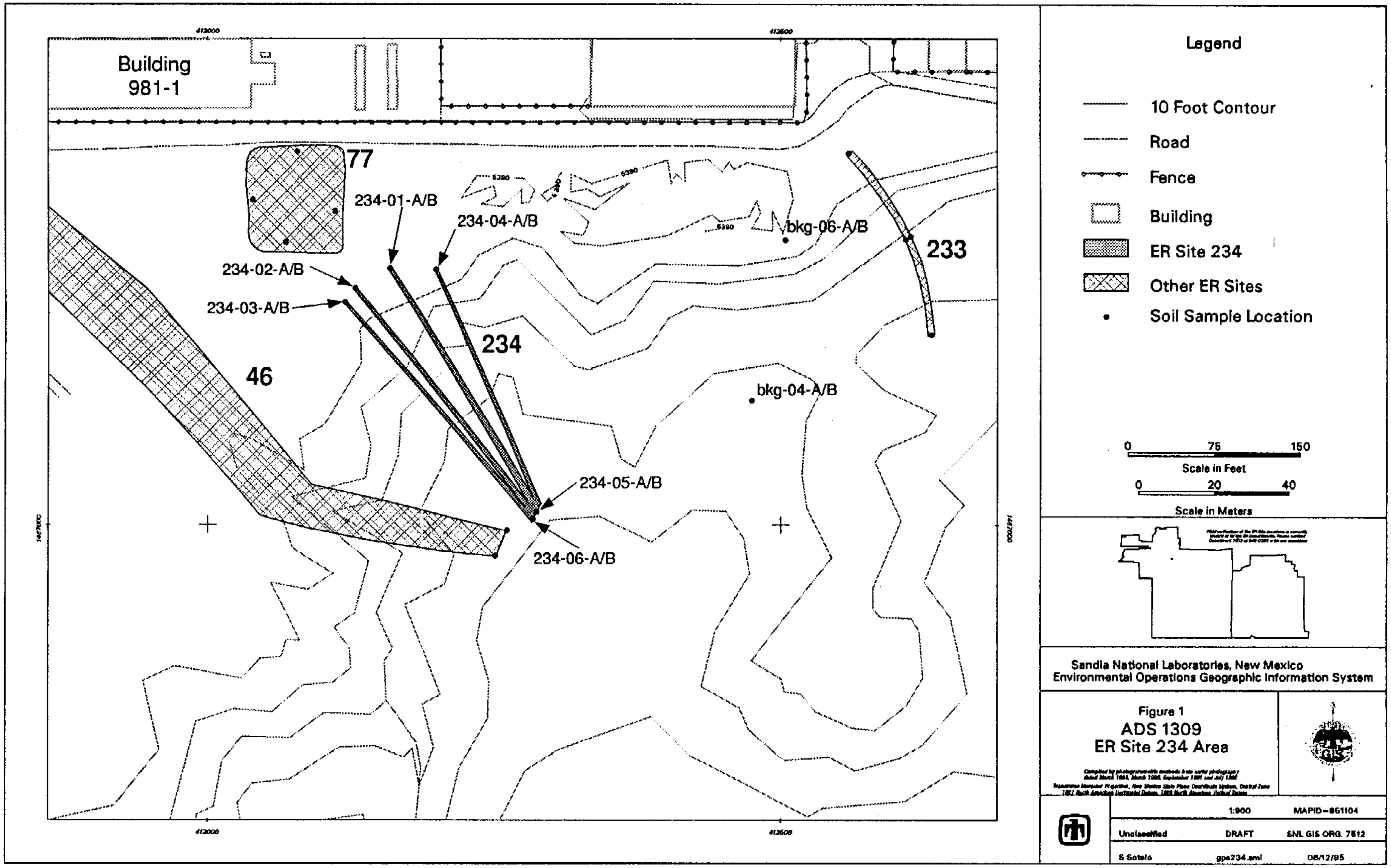

Figure 1. Storm Drain System Outfall Site 234.

Table 1. Site 234 - Results of Shallow Soil Sampling and Analysis

Sample Identifier	Analytical Method	Constituent	Concentration (mg/kg)	Qualifier(s)	Background (mg/kg)	Action Level (mg/kg)
234-01-B	VOCs (8240)	2-butanone	0.002	JB		
234-02-B	VOCs (8240)	2-butanone	0.003	JB		
234-03-B	VOCs (8240)	2-butanone	0.005	JB		
234-04-B	VOCs (8240)	2-butanone	0.004	JB		
234-05-B	VOCs (8240)	2-butanone	0.003	JB		
234-06-B	VOCs (8240)	2-butanone	0.004	JB		
234-05-A	SVOCs (8270)	Benzo(b) fluoranthene	0.043	J		
234-05-A	SVOCs (8270)	Benzo(a) pyrene	0.048	J		
234-03-A	SVOCs (8270)	Bis (2-ethylhexyl) phthalate	0.28	JB		
234-05-A	SVOCs (8270)	Chrysene	0.062	J		
234-05-A	SVOCs (8270)	Pyrene	0.034	J		
234-01-A	Tritium (600 906.0)	Tritium	0.23 (pCi/g)			12.6 pCi/g
234-05-A	Tritium (600 906.0)	Tritium	0.038 (pCi/g)			12.6 pCi/g
234-01-A	Gamma Spec (In-house)	Radium-226	2.27 pCi/g		1.94 pCi/g	125 pCi/g

Notes

A "J" qualifier means detected at a concentration below the laboratory reporting limit.

A "B" qualifier means detected in the associated blank sample.

For radium-226, background is the 95 percent upper tolerance level for the base-wide data.

The action levels for tritium and radium-226 are calculated risk-based levels.

Table 2. Risk Calculations for Site 234

Constituent	Activity (pCi/g)	DCF(I) (mrem/pCi)	Individual Dose (mrem/year)	Source of DCF
Radium-226	2.27E+00	1.10E-03	1.82E-01	Gilbert et al., 1989
Tritium	2.30E-01	6.30E-08	1.06E-06	Gilbert et al., 1989
Summed Dose			1.82E-01	

APPENDIX A

Confirmatory Sampling and Analysis Plan

APPENDIX B

Analytical Results

APPENDIX C

Background Calculations for Metals and Radionuclides

APPENDIX D

Probability Plots, Local Background UTL Calculations, and Base-wide Background UTLs for Radionuclides

SAMPLING AND ANALYSIS PLAN FOR ELEVEN SITES IN TIJERAS ARROYO OPERABLE UNIT SANDIA NATIONAL LABORATORIES/ NEW MEXICO

Sampling and Analysis Plan for Eleven Sites in Tijeras Arroyo Operable Unit

Introduction

The purpose of the sampling and analysis described in this plan is to determine the appropriate way to proceed toward closure of 11 (of the 17) sites in the Tijeras Arroyo Operable Unit. Based on the surface and shallow subsurface soil samples and analyses for the constituents of concern (COCs), one of three approaches will be pursued for each site:

1. A petition for "No Further Action" (NFA) will be produced for regulatory consideration;
2. A voluntary corrective measure (VCM) will be designed and implemented, hopefully followed by an NFA petition; or
3. The site assessment and eventual closure will follow the standard RFI/CMS path

Most of the sites covered by this Sampling and Analysis Plan (SAP) are outfalls from the storm water and sanitary sewer systems emanating from Sandia Technical Areas (TAs) I, II, and IV. The general sampling program for the outfalls will be to collect four samples at the head of the outfall, two samples of surface soil (0 to 6 inches deep) and two samples of shallow subsurface soil (18 to 36 inches deep) and four samples (two surface soil and two shallow subsurface soil) at the furthest extent of channel erosion and scour. The analytes for most of the samples are volatile organic compounds, semi-volatile organic compounds (BNAs), metals, chromium$^{+6,}$ for samples where chromium is found in a metals analysis, total petroleum hydrocarbon (TPH), explosives, Total Kjeldahl Nitrogen (TKN), nitrate/nitrite, and Gamma Spectroscopy for radionuclides, isotopic uranium, isotopic plutonium, tritium, and chlorodiphenyls (PCBs).

Sampling Procedures and Volumes

Surface soil samples will be collected with a stainless steel scoopula or trowel and placed in a stainless steel bowl. After at least 1000 ml[1] of soil has been collected, the soil will be thoroughly mixed in the bowl and transferred to two or three 500-ml sample bottles with a stainless steel scoopula. Sample bottles will be labeled accordingly and the appropriate sample information (sample depth, collection date and time, etc.) will be documented on the chain-of custody (COC) after each sample is collected. Samples will then be packaged and cooled to 4 degrees Celsius.

Shallow subsurface soil samples (18-36 inches) will be collected with a 2-inch (minimum) hand auger. A soil sample is collected by turning the auger clockwise and advancing it into the ground until the bucket at the end of the auger (last 6-8 inches) is full of soil or refusal occurs. Several runs with the auger is anticipated in order to obtain the appropriate volume. A hand shovel may also be used to bypass large rocks in order to continue with the auger. The auger is then extruded counter-clockwise from the ground and the soil is removed from the auger and placed in a stainless steel bowl. After 1,125[2] ml of soil has been collected, the soil will be mixed in the bowl and transferred to two or three 500-ml sample bottles and one 125-ml sample bottle with a stainless steel scoopula. Sample bottles will be labeled accordingly and the appropriate sample information will be documented on the COC after each sample is collected. Samples will then be packaged and cooled to 4 degrees Celsius.

Waste Generation and Equipment Decontamination

Decontamination of sampling equipment will be done between each sample. Decontamination will include thoroughly washing the inside and outside of the sampling equipment with a spray of ALCONOX™ or LIQUINOX™ and water; rinsing with distilled,

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[1]The sample volume varies between 1,000 and 1,500 ml depending on the analyses for the sample.

[2]The sample volume varies between 1,125 and 1,625 ml depending on the analyses for the sample.

deionized water; and drying before reusing. No soil waste will be generated. The soil removed from the hand-auger holes, while collecting samples at a depth of 18 to 36 inches, will be return to the hole. The sampling tools, which are scoopulas/trowels, hand-augers, and shovels, will be decontaminated with water and ALCONOX™ after each use. The decon leachate will be stored in capped 1-gallon containers. One or two containers will be used for each site and two to four containers will be used for the background samples. The containers will be labeled as "IDW" and the site number identified on each container. All the containers will be stored at Site 232, a central location. The leachate waste will be disposed according to the analytical results of the soil samples collected at the site.

Site Descriptions

The sites that will be sampled are

- Site 46, Old Acid Waste Line Outfall;
- Site 50, Old Centrifuge Site;
- Site 77, Oil Surface Impoundment;
- Site 227, Bldg. 904 outfall;
- Site 229, Storm Drain System Outfall;
- Site 230, Storm Drain System Outfall;
- Site 231, Storm Drain System Outfall;
- Site 232, Storm Drain System Outfall;
- Site 233, Storm Drain System Outfall;
- Site 234, Storm Drain System Outfall; and
- Site 235, Storm Drain System Outfall.

The site locations are shown in Figure 1. A description of the site history, conditions, previous investigations, and sampling plans are described in the following sections.

Site 46: Acid Waste Line Outfall

The Old Acid Waste Line carried wastes from several buildings in TA I. The waste line begins as a north-south trending, 750-feet long open trench in a grassy field northwest of Building 981-1 in TA IV. No pipe opening is visible at the "head" of the trench. As the trench crosses the field, it turns to the southeast and continues to a non-engineered spillway at the edge of Tijeras Arroyo. The spillway lies on a bank (40 to 50 feet of relief) composed of compacted alluvial sediment. Historical aerial photographs show vegetation, presumably supported by the discharge, growing southeast of the spillway to the active arroyo channel (about 200 feet distance from the spillway). The site is not restricted and is easily accessible.

During use, discharged effluent averaged an estimated 130,000 gallons per day. Use of the line has been discontinued. The line received wastes from plating, etching, and photo processing operations, and cooling tower "blow down". Acids and metals are target contaminants. Chromic acid and ferric chloride are mentioned specifically in the site history, and ferric chloride was found in the soils during a limited sampling event. Various radionuclides, possibly including tritium, uranium, and plutonium were used in TA I.

Building 863 was a source of discharge to the Acid Line. The information sheet for ER Site 98 (Building 863, TCA Photochemical Release: Silver Catch Boxes) indicates the presence of trichloromethane, silver, and photo-processing chemicals with an ammonia-like odor. The waste solution from the silver recovery unit reportedly was discharged to the Old Acid Waste Line, which is the only specific information about chemical discharges.

The site has been visually surveyed for surface indications of unexploded ordnance and high explosives (UXO/HE). No UXO/HE were found. Also, a surface radiation survey was conducted on the entire site. No surface radiation anomalies were detected.

The sampling program includes four samples collected at the "head" of the site outfall (by the fire extinguisher training area west of TA IV) and four samples collected by the spillway into the Tijeras Arroyo drainage (Figure 1). Every sample will be analyzed for tritium, metals, chromium^{+6} (if chromium is detected), TKN, and nitrate/nitrite. Half the samples will also be analyzed for semi-volatiles and cyanide. Additionally, all the subsurface samples will be analyzed for volatiles. The analytes are listed in Table 1. A "4" on the table indicates that ALL the samples will be analyzed
for that specific analyte whereas a "2" on the table indicates half the samples will have additional analyses for the analyte listed.

Site 50: Old Centrifuge

Site 50, Old Centrifuge, was an outdoor, rocket propelled centrifuge that was used in the early 1950s to test units under G forces. The facility is located east of the TA II fence in a slight depression on top the escarpment northwest of Tijeras Arroyo. The concrete centrifuge pad has a diameter of 80 to 90 feet. The site has a 7-foot high wooden retaining wall on the north, east, and south sides. The west side is open. The centrifuge arm assembly, which has a 20-foot radius, is sitting outside the wall to the north and appears to be intact. Control wiring to the center axis of the centrifuge was suspended from a cable between two telephone poles on the north and south side of the pad. The control wiring went to a bunker located to the southwest over the escarpment. The bunker had a electrical transformer containing PCB. The electrical transformer has been removed. The pad was not stained and no spills or leaks were reported.

The centrifuge was rocket driven by two T40 6-KS-3000 or two Deacon 3.5DS-5700 solid rocket motors. The combustion byproducts produced by these rocket motors were carbon dioxide, carbon monoxide, water, hydrochloric acid, aluminum oxide, and possibly barium oxide. No other HE is known or suspected at the site. The rocket orientation would expel combustion byproducts towards the retaining wall and the opening to the west. The rocket propellant would be consumed in the rocket motor case. Under normal operating conditions, no unburned propellant would be released.

In 1987, a reconnaissance investigation at five potential contaminated sites, including the Old Centrifuge Site, was conducted by the ER Project. Samples were analyzed for uranium, TNT, HSL inorganics, TCLP constituents, and EP Toxicity constituents. Metals, including barium, were detected at concentrations well below regulatory action levels. Total uranium concentrations were typical of area background levels. TNT, pesticides, PCBs, herbicides, and semi-volatiles TCLP compounds were not detected.

Prior to sampling, the surface will be surveyed for radiation. If contamination exists, it is expected to be around the edge of the centrifuge pad at the surface, probably along the open west side. The constituents of concern are metals (specifically lead, beryllium, and barium), depleted uranium, and high explosives. Four surface samples and four subsurface samples will be collected. The sampling locations will be biased toward the west side of the site because that is the open side (Figure 1). All surface samples will be analyzed for all the COCs. One-half of the subsurface samples will be analyzed for uranium and high explosives. All four subsurface samples will be analyzed for metals.

Site 77: Oil Surface Impoundment

The Oil Surface Impoundment Site is outside the TA IV fence, southeast of Building 981-1. The surface impoundment, which was constructed in the 1970's, is used to catch waste water from accelerators. At the time of the RCRA facilities environmental survey, the impoundment was unlined. Since then the impoundment was drained. Soil samples were analyzed for PCBs and solvents. Based on the analytical results, the impoundment was determined to be clean. Subsequently, the impoundment was lined with geotextile and is now regulated under Sandia's Surface Water Discharge Program.

This site will not require UXO/HE or radiation surface surveys. Minimal confirmation sampling and analysis is proposed to verify that the site is clean. Three surface and three shallow subsurface samples are proposed. The samples will be collected along the perimeter of the existing lined pond (Figure 1). All the samples will be analyzed for PCBs. The subsurface soil samples also will be analyzed for volatile organic compounds (Table 1).

Site 227: Bunker 904 Outfall
Site 227 is an inactive outfall from the septic system for Building 904 (ER Site 48) in TA II. The site starts where the discharge exits the septic tank piping system, approximately 100 feet northeast of the southernmost point of TA II. The extent of the area influenced by the discharge may include the bank of Tijeras Arroyo below the outfall and some area between the outfall and the main channel of Tijeras Arroyo. The site is along the eastern edge of ER Site 45.

Building 904, built in 1948, was used for weapons assembly, HE testing, photo processing, and various other testing. Sanitary wastes were discharged to a septic tank, and other wastes were discharged to the outfall.

Mineral oil is also being considered a potential soil contaminant at all outfalls along the Tijeras Arroyo due to a recent release (June 1994) of mineral oil at Outfall 232 and vague historical records.

Possible soil contaminants are explosives, radioactive materials from weapons processing, including tritium, uranium, and plutonium, solvents (acetone, methylene chloride, methyl ethyl ketone, carbon tetrachloride, toluene, xylene, hexane, alcohols), and inorganics (ammonium hydroxide, barium, cadmium, silver, chromium, titanium, cyanide).

Access to this site is along the TA II perimeter road. This site is within the TA II testing exclusion zone. The best days to sample are generally Friday, Saturday, and Sunday, when testing ceases. Bruce Berry (telephone 845-8018) must be contacted to gain permission and access to this site. Prior to sampling

1. tumbleweeds will be cleared from locations to be sampled and placed adjacent to the drainage;
2. these locations will be visually scanned for UXO/HE; and
3. these locations will be screened for surface radiation anomalies.

The proposed sampling program is to collect four surface soil samples and four shallow subsurface samples. Two surface and two subsurface samples will be collected at the outfall. The other two surface and two subsurface samples will be collected at the furthest visible channel erosion and scour (Figure 1). The analytes are listed in Table 1.

Sites 229 - 235: Storm Drain Systems Outfalls
These sites consist of the discharge areas at seven outfalls along the northern embankment of Tijeras Arroyo. The outfalls discharged industrial effluent and storm water from TAs I, II, and IV. Presently they only discharge storm water. The outfalls receive runoff from Site 96 (Storm Drain System) and other engineered drain systems within the three TAs. The sites are along approximately ¾ miles of the embankment.

The specific constituents in the industrial effluent at these sites are not known. The possible discharged contaminants include chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, and other petroleum products. To cover this array of possible contaminants, soil samples will be analyzed for volatiles (subsurface samples only), semi-volatiles, metals and chromium^{+6}, if chromium is found in the metals analysis.

Mineral oil is also being considered a potential soil contaminant at all outfalls along the Tijeras Arroyo due to a recent release (June '94) of mineral oil at Outfall 232 and vague historical records. Therefore, soil samples will also be analyzed for TPH.

At Sites 229 through 234, prior to sampling

1. tumbleweeds will be cleared from locations to be sampled and placed adjacent to the drainage;
2. these locations will be visually scanned for UXO/HE; and
3. these locations will be screened for surface radiation anomalies.

Site 229 is due east of the footings of the old guard tower and the south "corner" of the TA II fence. It discharges near the top of the embankment through the center of ER Site 45. Access to this site is along the TA II perimeter road. This site is within the TA II testing exclusion zone. The best days to sample are generally Friday, Saturday, and Sunday, when testing ceases. Bruce Berry (telephone 845-8018) must be contacted to gain permission and access to this site. Because this site discharges from TA II, various radionuclides, possibly including tritium, uranium, and plutonium are of concern. Four surface soil and four subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Site 230 is west of Building 970 in TA IV. A drain pipe discharges into a bowl-shaped concrete structure adjacent to Building 970A. Flow from this structure is directed to a drain and flume located approximately 120 feet further west. The flume carries the flow to a discharge point slightly above the base of the arroyo embankment. Doug Bloomquist (845-7455) must be contacted to ensure that no laser testing is being performed in the area. Four surface soil and four subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Site 231 is west of Building 970 in TA IV. A drain pipe discharges to a concrete flume near the top of the embankment. The flume carries the flow to a discharge point near the base of the slope. Doug Bloomquist (845-7455) must be contacted to ensure that no laser testing is being performed in the area..Four surface soil and four subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Site 232 consists of two outfalls. One outfall is south of Building 970A, east of the lined lagoon. A drain pipe discharges to a concrete flume near the top of the embankment. The flume carries the flow to at discharge point near the bottom of hillside. On June 1, 1994, about 150 to 350 gallons of mineral oil was spilled into this outfall through the storm water drain by building 986. The day after the spill the site was screened for radiation and UXO/HE. No surface radiation anomalies or UXO/HE were found. Also, four surface soil and four subsurface soil samples were collected. The samples were sent to Quintera Laboratory in Denver for analysis for organics, metals, chromium^{+6}, and gamma spec. Other than TPH from the mineral, no contaminants were detected. A Voluntary Corrective Measure was conducted in July and August to remove soil contaminated with mineral oil above 100 mg/kg of TPH.

The second outfall in Site 232 also is south of Building 970A, west of lined lagoon, and approximately 120 feet east of the other Site 232 outfall. Discharge occurs from a concrete structure opening near base of embankment. Access to the site is along the road outside the south side of TA IV. Four surface soil and four subsurface soil samples will be collected at this drainage Figure 1). The analytes are listed in Table 1.

Site 233 is south-southwest of Building 986. Near the top of an escarpment, a small metal drain pipe discharges to an open drain which directs flow within another pipe before discharging near the base of the hillslope. Access to the site is along the road outside the south side of TA IV. Four surface soil and four subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Site 234 is southeast of Building 981I (Inflatable Building) and a lagoon impoundment (Site 77).

The site discharges into a steep-sided, deeply incised channel cut into the hillside. The drainage channel splits directly uphill of a tree. Access to the site is along the road outside the south side of TA IV. Both channels will be sampled. Six surface soil and six subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Site 235 is immediately downstream of a large concrete spillway on the northeast side of Pennsylvania and south of the Skeet Range, at the point where the road comes off the north bank of the arroyo and descends into the channel. The flow moves in a confined channel after dropping down the spillway. The site has been cleared for visible surface UXO/HE and screened for surface radiation with no anomalies detected. This channel is considerably larger than the other outfall sites. Six surface soil and six subsurface soil samples will be collected at this site (Figure 1). The analytes are listed in Table 1.

Background

Background soil concentrations for organic contaminants should be negligible. Background concentrations for total metals and radionuclides must be determined for comparison to concentrations found at the sites. Twelve locations have been identified to collect samples for background determination (Figure 1). At each of these sites, one sample will be collected at a depth of 0-6 inches and a second sample collected at 18-36 inches (Table 1).. In addition, the background study report prepared by International Technology Corporation (May 1994) will also be used to evaluate the data.

Quality Assurance

As shown in Table 1, quality assurance samples will include the following:

- Field "duplicates" on more than 10 percent of the samples. These samples will be collected adjacent to the original surface soil sample and in the same hole as the original subsurface soil sample;
- Field soil blanks for more than 10 percent of the VOC analyses. These sample will be obtained from Sample Management Office (SMO) and will contain no VOCs; and
- One rinsate blank. All rinsate will be composited in one container. A sample of the rinsate will be analyzed for all constituents. The disposal method for the rinsate will be determined by the analytical results on this sample.

Sampling and Analysis Plan

Surface Soils

Site	Site Name	Potential Contaminants	Number of Samples	BNAs (8270)	TAL Metals (6010/7000)	Cr^{+6}* (aqueous leaching)	Cyanide (acid digestion)	TPH (8015)	Explosives Res (8330)	TKN (acid digestion)	NO_3/NO_2 (353.2)	Gamma Spec (In-House) 600 901.1	Gamma Spec (Off-site) 600 901.1	PCBs (8080)	Tritium (600 906.0)	Isotopic Plutonium (600 7-79-081)	Isotopic Uranium (HASL-300 4.5)
46	Old Acid Waste Line Outfall (Tijeras Arroyo)	Ferric chloride, chromic acid and other acids, ammonia, photo processing chemicals and other unknown chemicals	4	2	4	4	2			4	4	4	2		4	2	2
50	Old Centrifuge Site (TA-2)	Rocket propellant and residues	4		4				4			2			2	1	2
77	Oil Surface Impoundment	Solvents and PCBs	4											4			
227	Bldg. 904 outfall (TA-2)	High explosives, radioactive materials, nitrate, toluene, methanol, other solvents, carbon tetrachloride, ammonium hydroxide, barium, cadmium, silver, chromium, titanium, cyanide	4	2	4	4	2	2	2	4	4	4	2		4	2	2
229	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				4	2		4	2	2
230	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2			2	1	1
231	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2			2	1	1
232	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2			2	1	1
233	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2			2	1	1
234	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	6	3	6	6		6				2			2	1	1
235	Storm Drain System Outfall	Chromates, antifoulants, chromium, sodium hydroxide, hydrochloric acid, chromosulfuric acid, diesel, other petroleum products	4	2	4	4		4				2			2	1	1
Na	Background		12		12							12			3	3	3
QA	Duplicates	Na		2	5	4	1	4	1	1	1		1	1			2
QA	Field Soil Blank	Na															
QA	Rinsate	Na		1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Totals		58	22	60	43	6	37	8	10	10	39	8	6	30	17	20
	Totals - Surface Plus Subsurface		116	43	120	85	11	75	13	19	19	75	8	11	46	26	31

Subsurface Soils

Site	Site Name	Number of Samples	VOCs (8240)	BNAs (8270)	TAL Metals (6010/7000)	Cr^{+6}* (aqueous leaching)	Cyanide (acid digestion)	TPH (8015)	Explosives Res (8330)	TKN (acid digestion)	NO_3/NO_2 (353.2)	Gamma Spec (In-House) 600 901.1	Gamma Spec (Off-site) 600 901.1	PCBs (8080)	Tritium (600 906.0)	Isotopic Plutonium (600 7-79-081)	Isotopic Uranium (HASL-300 4.5)
46	Old Acid Waste Line Outfall (Tijeras Arroyo)	4	4	2	4	4	2			4	4	4			4	2	2
50	Old Centrifuge Site (TA-2)	4			4				2						1		1
77	Oil Surface Impoundment	4	4											4			
227	Bldg. 904 outfall (TA-2)	4	4	2	4	4	2	4	2	4	4	4			4	2	2
229	Storm Drain System Outfall	4	4	2	4	4		4				4			4	2	2
230	Storm Drain System Outfall	4	4	2	4	4		4				2					
231	Storm Drain System Outfall	4	4	2	4	4		4				2					
232	Storm Drain System Outfall	4	4	2	4	4		4				2					
233	Storm Drain System Outfall	4	4	2	4	4		4				2					
234	Storm Drain System Outfall	6	6	3	6	6		6				2					
235	Storm Drain System Outfall	4	4	2	4	4		4				2					
Na	Background	12			12							12			3	3	3
QA	Duplicates		5	2	5	4	1	4	1	1	1			1			1
QA	Field Soil Blank		5														
QA	Rinsate		1		1												
	Totals	58	53	21	60	42	5	38	5	9	9	36		5	16	9	11
	Totals - Surface Plus Subsurface		53														

* Analyze for Cr^{+6} only if Cr is detected in metals analysis

Appendix B
Analytical Results

Site 234 Soil Results

Sample Identifier	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Potassium
234-01-A	9300	16	1.6	210	0.5	2	42000	7.4	4.7	9.1	11000	10	4600	230	ND	8	1800
234-01-B	7800	13	1.6	190	0.4	2	46000	7.3	4.7	10	11000	9.4	4300	220	ND	8	1600
234-02-A	4700	8	5.3	140	0.3	2	50000	6.9	4.1	9.3	12000	8.7	2400	140	ND	6	1100
234-02-B	4500	8	1	160	ND	3	31000	7	5.7	9.6	12000	7.1	2200	130	ND	5	1100
234-03-A	6700	12	1.8	180	0.4	3	30000	11	4.1	13	9500	12	3500	210	ND	8	2300
234-03-B	6400	11	4.8	210	0.3	2	65000	11	3.5	9.8	9000	8.2	3200	180	ND	8	1800
234-04-A	5800	11	6.3	240	0.3	2	61000	5	3.9	8.5	8800	8.2	3500	130	ND	6	1400
234-04-B	6400	11	5.4	220	0.3	2	48000	5	4.1	7.2	10000	6.2	4100	150	ND	5	1400
234-05-A	7600	13	1.6	180	0.4	2	32000	7.6	4.8	9.5	12000	10	4400	260	ND	8	3200
234-05-B	6100	11	0.9	180	0.3	3	27000	6.7	4.5	9.8	13000	9.1	3500	210	ND	8	2200
234-06-A	11000	17	7	220	0.5	3	34000	9.9	4.9	11	13000	13	4800	260	ND	10	2600
234-06-B	3600	7	1	150	0.2	2	31000	5.4	3.6	9.6	8800	6.5	2300	150	ND	6	870

Sample Identifier	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc	Cr^{+6}	Radium-226	Radium-226	Radium-228	Tritium	Plutonium 239/240	Plutonium 238	Uranium-238	Uranium-235/236	Uranium-234
234-01-A	ND	ND	450	ND	23	64	ND	2.3			0.23	<0.004	<0.008	0.4	<0.013	1
234-01-B	ND	ND	480	ND	24	64	ND	NS								
234-02-A	ND	ND	320	ND	24	64	ND									
234-02-B	ND	ND	430	ND	24	77	ND									
234-03-A	ND	ND	300	ND	18	67	ND									
234-03-B	ND	ND	290	ND	21	57	ND									
234-04-A	ND	ND	320	ND	24	55	ND									
234-04-B	ND	ND	340	ND	30	57	ND									
234-05-A	ND	ND	300	ND	22	70	ND	NS	0.7	0.8	0.038					
234-05-B	ND	ND	320	ND	25	64	ND	NS								
234-06-A	ND	ND	360	ND	28	73	ND									
234-06-B	ND	ND	250	ND	18	47	ND									

Concentrations in mg/kg
Activities in pCi/g
Sample Identifier XX-XX-A - surface soil samples
Sample Identifier XX-XX-B - subsurface soil samples

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Quality Assurance Results for Organic Constituents

Sample Identifier	Sample Type	2-Butanone	2-Hexanone	4-Methyl-2-pentanone	Acetone	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Chrysene	Di-n-octyl phthalate	Fluoranthene	Methylene Chloride	Phenanthrene	Pyrene	Styrene	total-Xylenes	TPH
227-01-A	original										0.066 J		0.055 J	0.040 J			
227-01-A	duplicate										0.038 J		0.051 J				
227-01-B	original	0.007 J		0.001 J													
227-01-B	duplicate	0.006 J			0.006 J												
227-04-B	original	0.004 J															
227-04-B	duplicate	0.005 J															
229-01-A	original					0.071 J	0.050 J	0.16 J	0.11 J		0.23 J		0.17 J	0.19 J			ND
229-01-A	duplicate					0.006 J	0.092 J	0.16 J	0.12 J		0.20 J		0.18 J	0.28 J			81
229-02-B	original	0.006 J															
229-02-B	duplicate	0.006 J															
229-03-B	original	0.006 J															
229-03-B	duplicate	0.006 J															
230-04-B	original	0.003 JB								0.16 J							
230-04-B	duplicate																
235-02-B	original	0.006 JB															
235-02-B	duplicate	0.004 JB															
Site 227	trip blank	0.010 B	0.003 J	0.002 J	0.019												
Site 229	trip blank	0.009 JB			0.015												
Site 230	trip blank	0.004 JB										0.003 J					
Site 232	trip blank	0.007 JB															
Site 234	trip blank	0.007 JB			0.015										0.001 J		
Site 235	rinsate	0.005 JB			0.010											0.001 J	ND

Quality Assurance Results for Inorganic and Radiological Constituents

Sample Identifier	Sample Type	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Nickel	Vanadium	Zinc
227-02-A	original	5800	9.3	5.9	180	ND	2.1	6.6	4.1	7.8	13000	7.5	160	ND	5.4	27	51
227-02-A	duplicate	6500	11	1.4	150	0.25	2.5	6.4	4.1	13	14000	9.1	170	ND	5.9	28	51
227-03-B	original	5100	8.8	0.92	140	ND	2.1	5.9	4.5	11	13000	7.5	200	ND	5.4	25	48
227-03-B	duplicate	6400	9.9	5.6	140	0.25	2.9	7.4	4.6	10	16000	8.9	230	ND	5.9	33	50
229-04-A	original	8100	13	5.7	150	0.32	2.3	8.0	4.2	7.9	13000	12	210	ND	6.3	24	55
229-04-A	duplicate	7700	12	1.5	140	0.30	2.2	8.0	4.2	7.7	12000	11	190	ND	6.2	24	52
230-04-B	original	1500	3.3	1.6	130	ND	0.61	2.3	ND	18	3500	4.2	110	ND	3.0	9.1	82
230-04-B	duplicate	2400	4.9	1.7	140	ND	0.68	3.1	2.5	15	4500	4.1	120	ND	3.4	9.7	71
235-01-A	original	3600	6.2	5.1	150	ND	2.7	6.0	8.4	6.6	20000	7.6	210	ND	4.5	36	66
235-01-A	duplicate	3000	5.3	1.3	160	ND	1.6	4.2	5.7	6.5	12000	9.4	180	ND	4.4	22	66
50-01-B	original	3100	6.5	2.1	110	0.25	1.3	4.1	3.9	6.2	7600	6.6	130	ND	4.5	17	18
50-01-B	duplicate	3900	7.5	2.0	110	0.26	1.3	4.3	4.0	5.7	8800	5.9	150	ND	4.2	18	21
50-02-A	original	5800	12	4.2	220	0.38	1.6	5.2	4.3	12	6700	25	210	ND	7.1	11	69
50-02-A	duplicate	7000	14	6.4	280	0.55	2.2	8.3	6.1	17	9000	35	290	0.04	9.4	18	61
Bkg-05-A	original	6400	13	5.7	210	0.53	1.8	6.1	6.6	14	10000	16	330	ND	8.9	22	37
Bkg-05-A	duplicate	5900	12	7.6	190	0.50	1.7	6.0	6.3	14	10000	16	320	ND	8.7	24	36
Site 235	rinsate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Sample Identifier	Sample Type	TKN	NO_3/NO_2	Potassium 40	Lead 212	Lead 214	Plutonium 239/240	Uranium 238	Uranium 235/236	Uranium 234
227-02-A	original	400	2.7							
227-02-A	duplicate	320	9.3							
227-03-A	original						0.004	0.4	0.15	0.61
227-03-A	duplicate							0.67	0.023	0.67
227-03-B	original							0.72	0.11	0.72
227-03-B	original	220	ND							
227-03-B	duplicate			27.8	0.71	0.7				
227-03-B	duplicate	190	1.4							
229-01-A	original						0.007	0.45	0.17	0.67
229-01-A	duplicate							0.73	0.034	0.6
229-03-B	original							0.45	0.058	0.45
229-03-B	duplicate							0.99	0.06	1

Notes on Quality Assurance Data

Explosive residues were not detected in Site 50 duplicate sample

Hexavalent chromium was not detected in five duplicates and one decon rinsate

Cyanide was not detected in two duplicates and one decon rinsate

PCBs were not detected in one Site 77 duplicate sample

Tritium and Plutonium-238 were not detected in four duplicate samples

Selenium, silver, and thallium were not detected in any quality assurance samples

Appendix C
Background Calculations for Metals and Radionuclides

Appendix C. Background Calculations for Metals and Radionuclides

To evaluate metals data, 24 background samples were collected for metals analyses.[4] Distribution analyses was performed first by constructing histograms. The histograms indicated a parametric distribution. Outliers were screened in a two-step process as described in the base wide background report (IT 1994). The first step is to perform an "a priori" screening for very high values relative to the rest of the data set. This is qualitatively performed by visually examining a column of sorted values. Maximum values that are a factor of 3 or 4 times higher than their nearest neighbor are removed from the data set during this step. None of the anomalous values were deleted by the "a priori" process.

The second step, from EPA, 1989, determines whether an observation that appears extreme fits the data distribution. A statistical parameter, T_n is calculated:

$$T_n = (X_n - X_a)/S$$

where:

X_n = questionable observation;

X_a = sample arithmetic mean; and

S = sample standard deviation

T_n is compared to a table of one-sided critical values for the appropriate significance level (upper 5 percent) and sample size from a table provided in EPA 1989. Extreme concentrations for barium, calcium, chromium, copper and nickel were identified as outliers and were excluded from the data set. These anomalous values may have resulted from laboratory or sampling error.

Probability plots were then replotted to determine whether the data fit normal or lognormal populations. These plots are shown in Appendix D. The UTL[5] was calculated for data sets that fit a normal or lognormal distribution. Data sets are provided in Appendix D. As recommended by EPA, a tolerance coefficient value of 95 percent was used (EPA 1989). Most metals background data fit lognormal distributions. Iron and zinc data fit normal distributions. UTLs were not calculated for mercury, selenium, and silver because mercury and selenium were not detected and silver was detected only once in the 24 background samples. The beryllium background data did not fit a normal or lognormal distribution. The maximum value in a data set is commonly taken as the UTL in a non-parametric setting (Guttman, 1970). The maximum background beryllium concentration was 0.53 mg/kg.

Base-wide background UTLs for radionuclides were established by International Technology (IT) Corporation to compare and evaluate radionuclide data (IT, 1994). A table is provided in Appendix

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[2]These data are referred to as local background data. The data collected throughout Kirtland Air Force Base (KAFB), with most of the data collected within SNL/NM technical areas, are called base-wide background data (IT 1994).

[3]$UTL = x + K \bullet S$, where:

UTL = Upper tolerance limit;

x = Sample arithmetic mean (for normal distribution), sample geometric mean (for lognormal distribution);

S = Sample standard deviation; and

K = One-sided normal tolerance factor (95 percent for these evaluations).

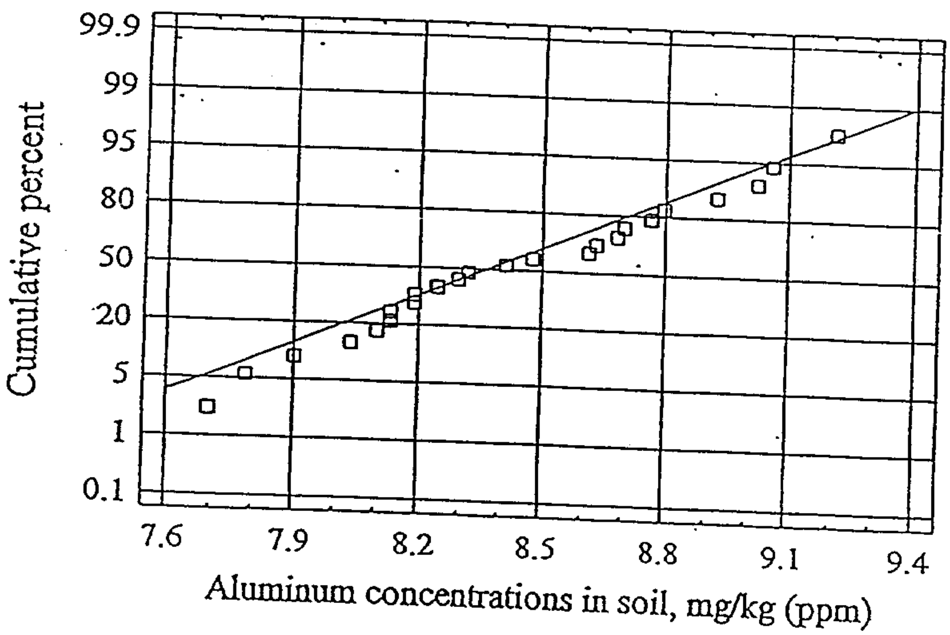
D with radionuclide background data and the corresponding UTLs. The maximum activity from the six local background samples for isotopic plutonium and isotopic uranium was used as an additional method to evaluate the data. Also, in-house gamma spectroscopy was performed on all 24 background samples and indicated low levels of radioactivity but no significant contamination.

Appendix D
Probability Plots, Local Background UTL Calculations, and Base-Wide Background UTLs for Radionuclides

y Statistics for log(Aluminum)

```
= 24
cage = 8.42942
ian = 8.36529
e =
metric mean = 8.41976
iance = 0.170246
ndard deviation = 0.412609
ndard error = 0.0842235
imum = 7.69621
imum = 9.21034
ge = 1.51413
er quartile = 8.13153
er quartile = 8.73178
erquartile range = 0.600253
ness = 0.132255
l. skewness = 0.26451
osis = -0.792361
. kurtosis = -0.792361
f. of variation = 4.89487
= 202.306
```

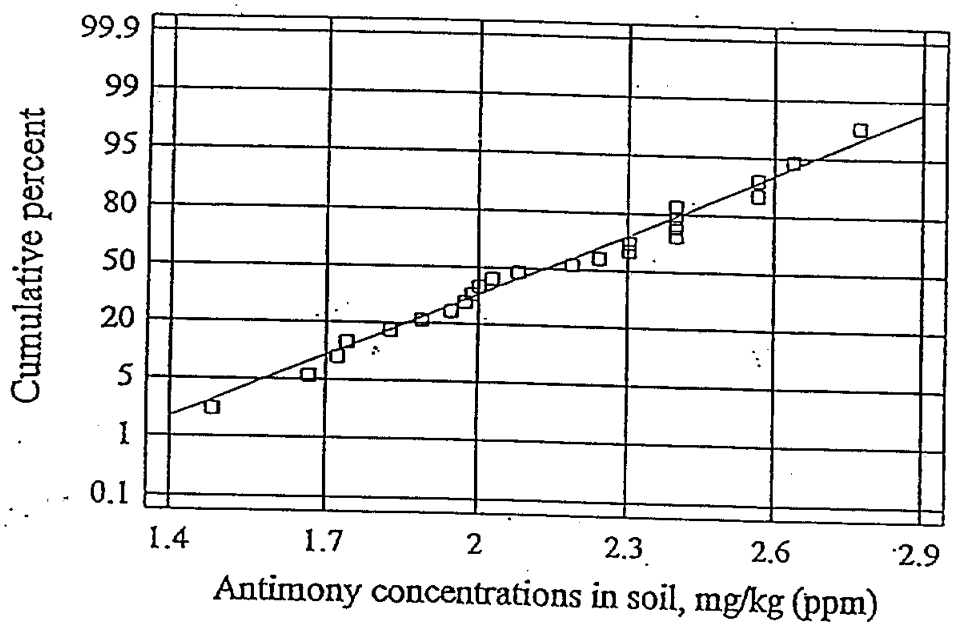
Lognormal Probability Plot for Aluminum



ummary Statistics for log(Antimony)

```
ount = 24
verage = 2.14609
edian = 2.13275
ode = 2.3979
eometric mean = 2.12004
riance = 0.113831
andard deviation = 0.337389
andard error = 0.0688692
nimum = 1.4816
ximum = 2.77259
nge = 1.29098
wer quartile = 1.91649
per quartile = 2.3979
terquartile range = 0.481405
ewness = -0.040772
nd. skewness = -0.0815441
rtosis = -0.744171
nd. kurtosis = -0.744171
eff. of variation = 15.7211
n = 51.5062
```

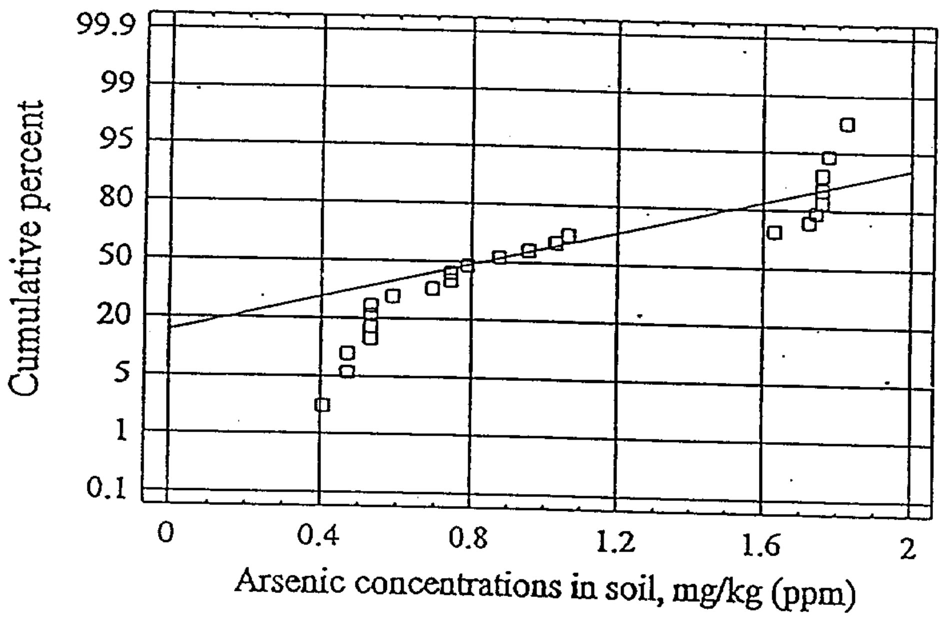
Lognormal Probability Plot for Antimony



mmary Statistics for Log(Arsenic)

= 24
...ge = 1.038
lian = 0.831963
le =
metric mean = 0.900119
iance = 0.291153
ndard deviation = 0.539586
ndard error = 0.110143
imum = 0.405465
imum = 1.82455
ge = 1.41908
er quartile = 0.530628
er quartile = 1.73162
erquartile range = 1.20099
mess = 0.463036
l. skewness = 0.926071
osis = -1.58507
l. kurtosis = -1.58507
f. of variation = 51.983
= 24.9121

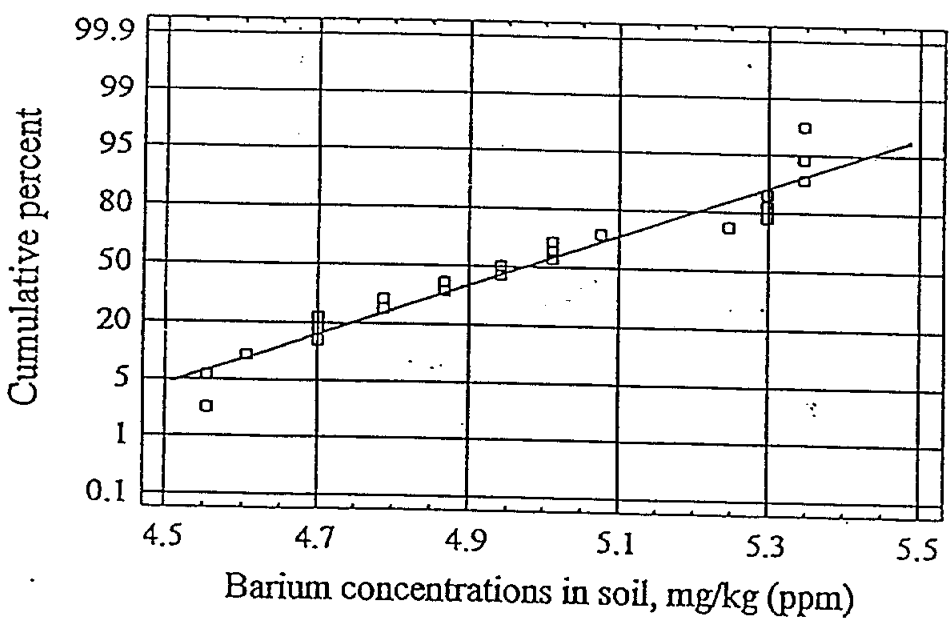
Lognormal Probability Plot for Arsenic



```
umary Statistics for Log(Barium)

unt = 23
erage = 4.96940
dian = 4.94164
de = 5.34711
metric mean = 4.96236
iance = 0.0740602
ndard deviation = 0.27214
ndard error = 0.0567451
imum = 4.55388
imum = 5.34711
ge = 0.793231
er quartile = 4.70048
er quartile = 5.29832
erquartile range = 0.597837
wness = 0.0653415
d. skewness = 0.127931
tosis = -1.30542
d. kurtosis = -1.27794
ff. of variation = 5.47622
= 114.298
```

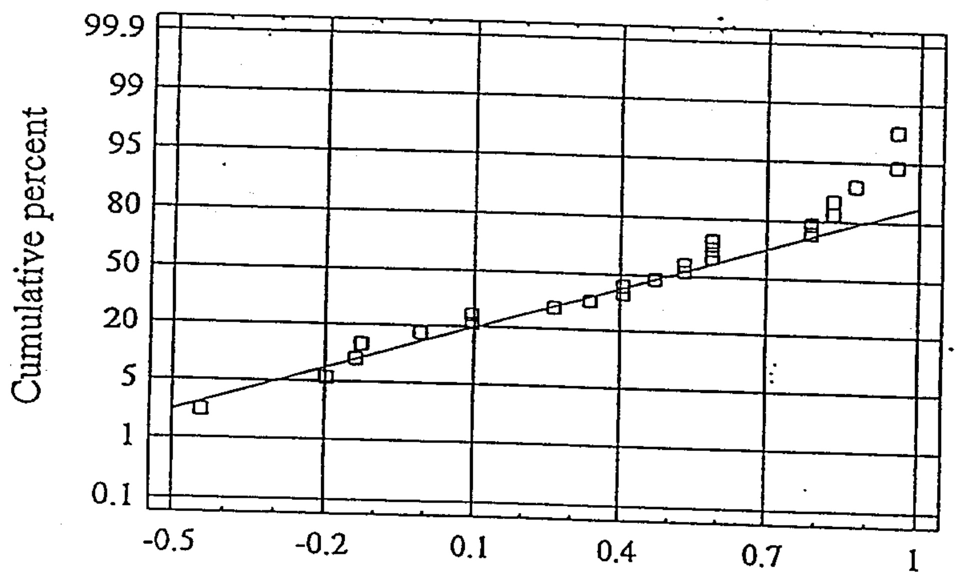
Lognormal Probability Plot for Barium



ummary Statistics for log(Cadmium)

= 24
ge = 0.416764
ledian = 0.500316
lode =
eometric mean =
ariance = 0.159937
tandard deviation = 0.399922
tandard error = 0.0816337
inimum = -0.446287
aximum = 0.955511
ange = 1.4018
ower quartile = 0.0953102
pper quartile = 0.788457
nterquartile range = 0.693147
cewness = -0.506707
nd. skewness = -1.01341
irtosis = -0.674504
nd. kurtosis = -0.674504
eff. of variation = 95.9587
im = 10.0023

Lognormal Probability Plot for Cadmium



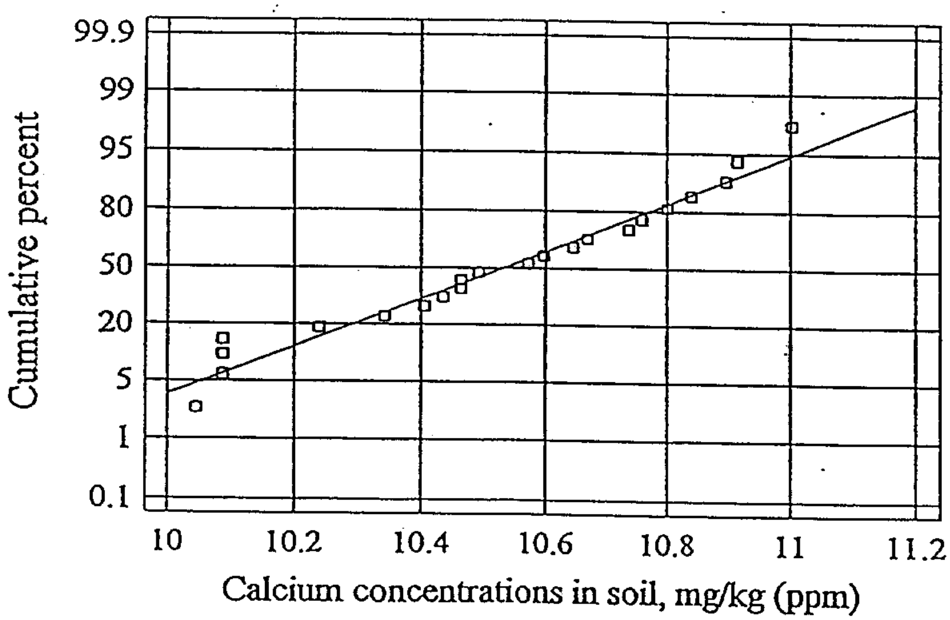
Cadmium concentrations in soil, mg/kg (ppm)

32

ımmary Statistics for log(Calcium)

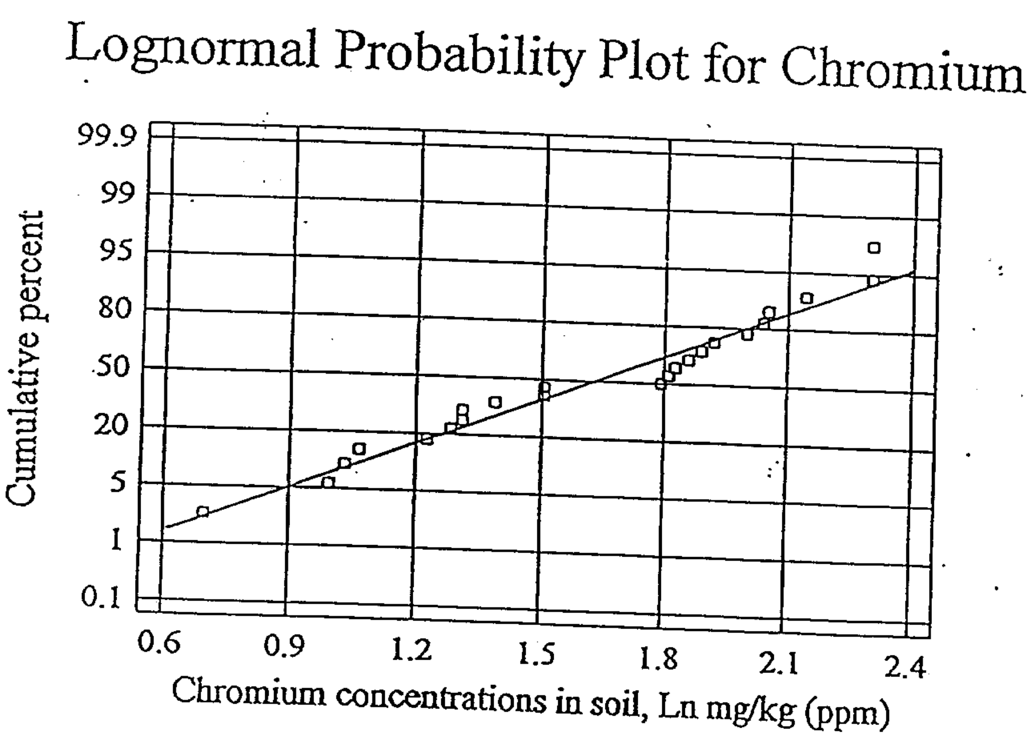
unt = 23
erage = 10.5579
dian = 10.5713
de = 10.0058
ometric mean = 10.5532
riance = 0.10513
andard deviation = 0.324237
andard error = 0.0676081
nimum = 10.0432
ximum = 11.2645
nge = 1.22121
ver quartile = 10.3417
per quartile = 10.7996
terquartile range = 0.457833
ewness = 0.109797
d. skewness = 0.214971
tosis = -0.415646
d. kurtosis = -0.406895
ff. of variation = 3.07103
= 242.832

Lognormal Probability Plot for Calcium



ry Statistics for log(Chromium)

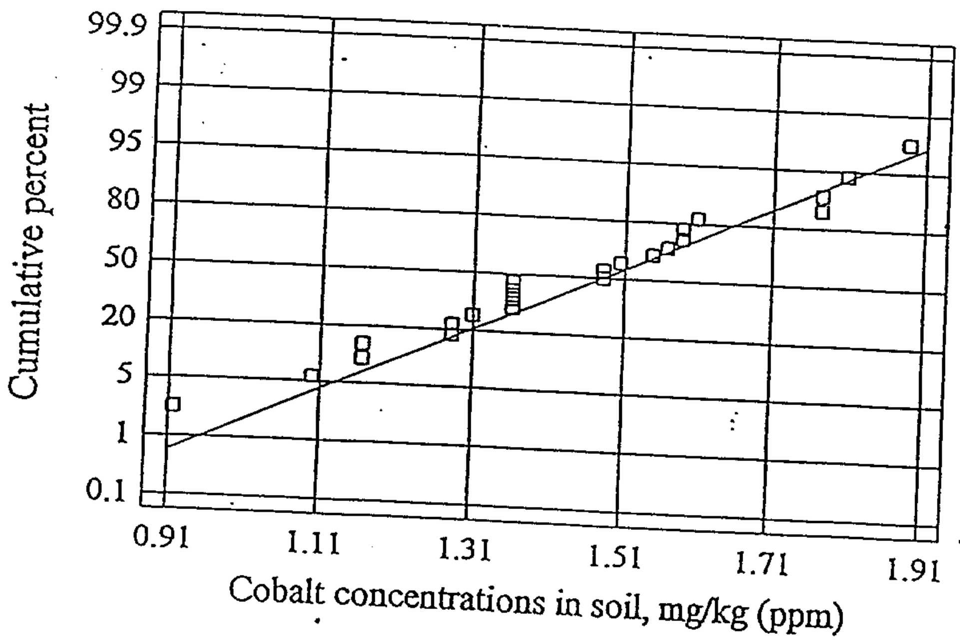
= 23
erage = 1.61841
dian = 1.79176
de =
ometric mean = 1.55042
riance = 0.204195
andard deviation = 0.451879
andard error = 0.0942233
nimum = 0.693147
ximum = 2.30259
nge = 1.60944
ver quartile = 1.28093
per quartile = 2.00148
erquartile range = 0.720546
wness = -0.274151
d. skewness = -0.536757
tosis = -0.905395
d. kurtosis = -0.886332
ff. of variation = 27.9211
= 37.2235



;ummary Statistics for log(Cobalt)

:ount = 24
\verage = 1.29969
iedian = 1.42129
iode =
eometric mean =
ariance = 0.574775
tandard deviation = 0.758139
tandard error = 0.154754
inimum = -2.07944
aximum = 1.88707
ange = 3.96651
ower quartile = 1.28093
pper quartile = 1.58924
iterquartile range = 0.308301
:ewness = -4.13299
:nd. skewness = -8.26598
ırtosis = 18.9091
:nd. kurtosis = 18.9091
eff. of variation = 58.3324
m = 31.1925

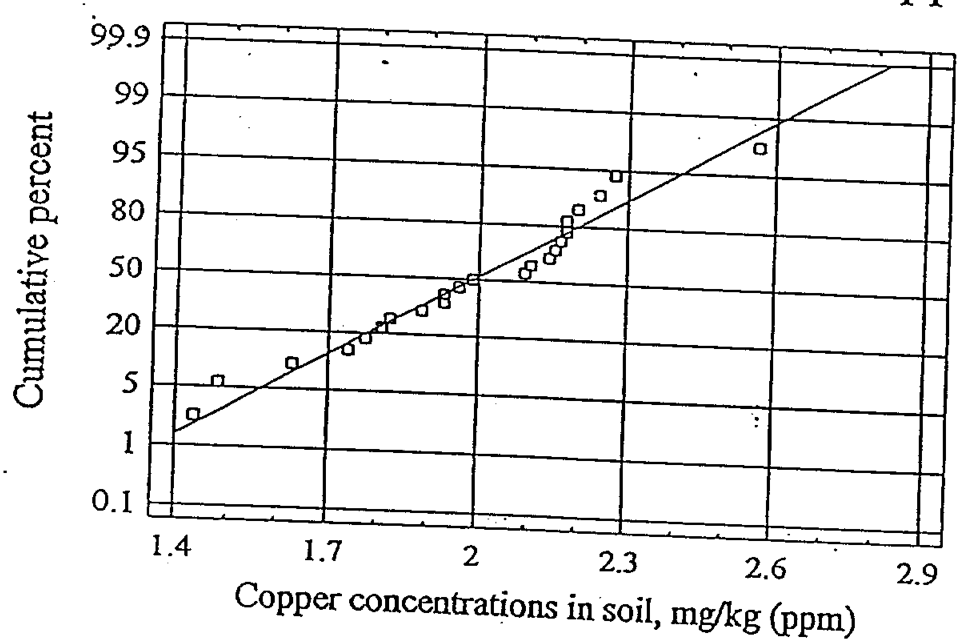
Lognormal Probability Plot for Cobalt



mmary Statistics for log(Copper)

= 23
age = 1.98556
dian = 1.98787
de =
ometric mean = 1.96762
riance = 0.0713494
ndard deviation = 0.267113
ndard error = 0.0556969
nimum = 1.43508
ximum = 2.56495
ge = 1.12986
er quartile = 1.80829
er quartile = 2.17475
erquartile range = 0.366463
wness = -0.263077
d. skewness = -0.515077
tosis = 0.18883
d. kurtosis = 0.184854
ff. of variation = 13.4528
= 45.6679

Lognormal Probability Plot for Copper

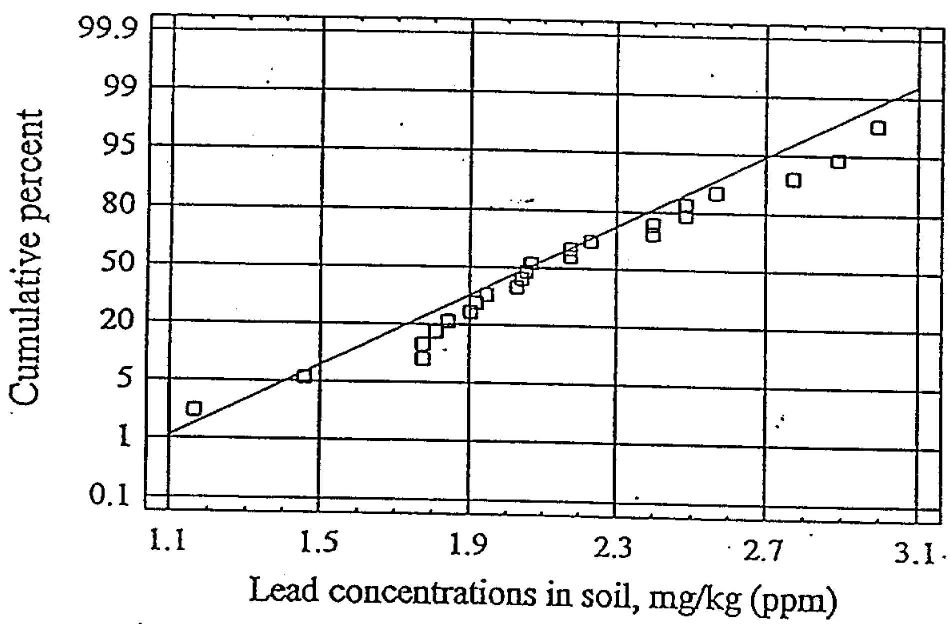


4

ummary Statistics for log(Lead)

ount = 24
verage = 2.13936
edian = 2.06049
ode =
eometric mean = 2.09509
ariance = 0.187882
tandard deviation = 0.433454
tandard error = 0.0884784
inimum = 1.16315
aximum = 2.99573
ange = 1.83258
ower quartile = 1.87133
pper quartile = 2.4414
nterquartile range = 0.570072
kewness = 0.0350174
nd. skewness = 0.0700348
rtosis = 0.200156
nd. kurtosis = 0.200156
eff. of variation = 20.261
m = 51.3446

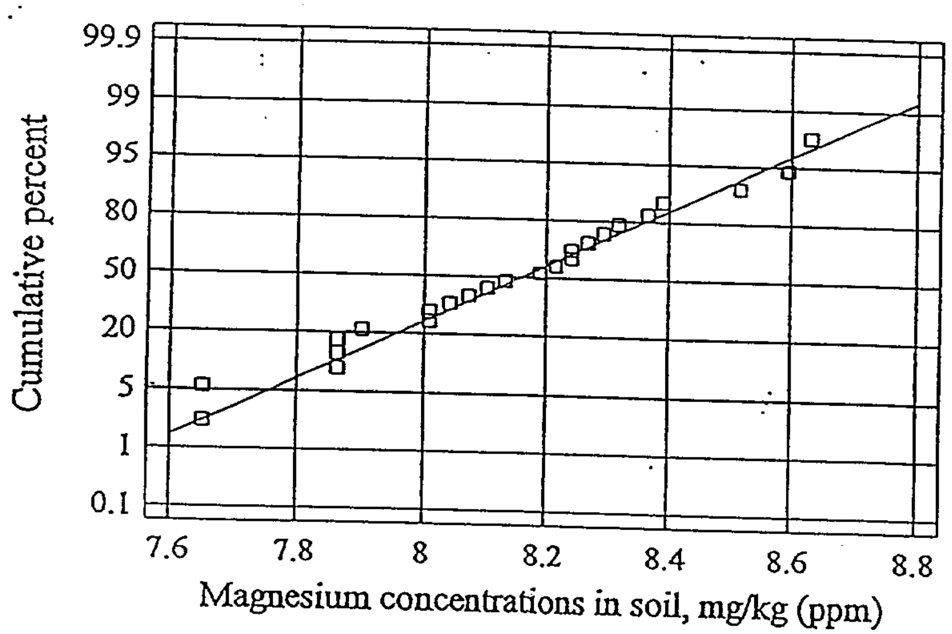
Lognormal Probability Plot for Lead



im y Statistics for log(Magnesium)

```
  = 24
erage = 8.14232
dian = 8.16011
de =
ometric mean = 8.13815
riance = 0.0706013
andard deviation = 0.265709
andard error = 0.0542376
nimum = 7.64969
ximum = 8.63052
nge = 0.980829
wer quartile = 7.95369
per quartile = 8.3064
erquartile range = 0.352709
wness = -0.0600481
d. skewness = -0.120096
tosis = -0.414246
d. kurtosis = -0.414246
ff. of variation = 3.26331
 = 195.416
```

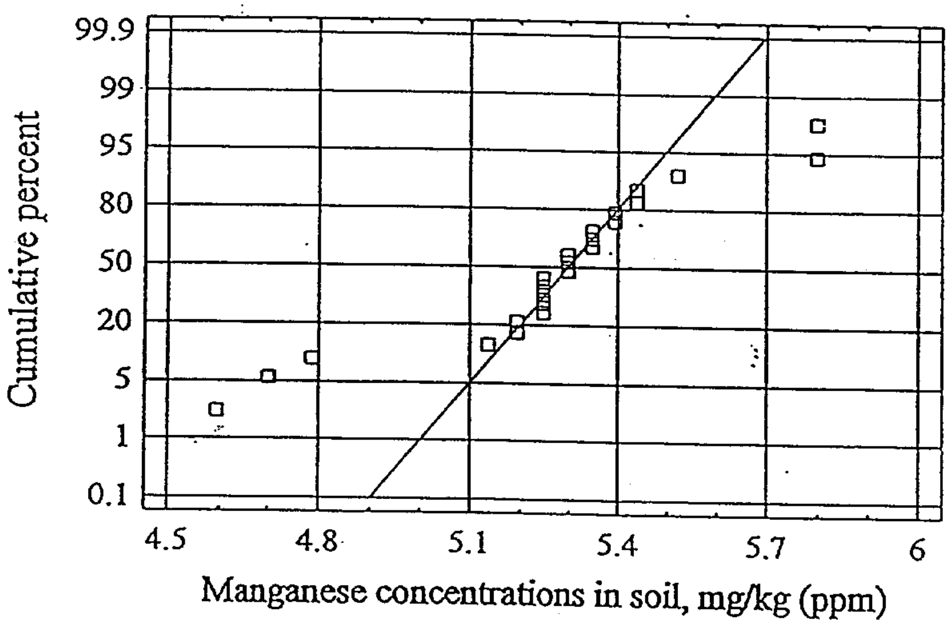
Lognormal Probability Plot for Magnesium



mmary Statistics for log(Manganese)

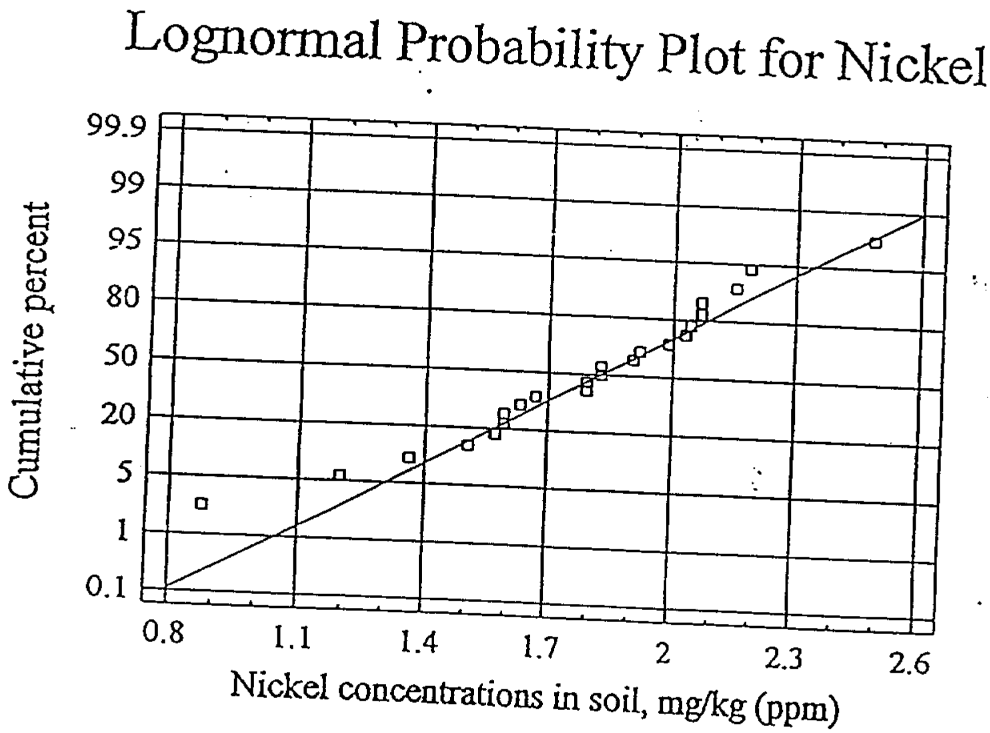
unt = 24
erage = 5.2733
dian = 5.29832
de =
ometric mean = 5.2661
riance = 0.0771874
andard deviation = 0.277826
andard error = 0.056711
nimum = 4.59512
ximum = 5.79909
nge = 1.20397
wer quartile = 5.21999
per quartile = 5.39363
terquartile range = 0.173637
ewness = -0.660387
d. skewness = -1.32077
rtosis = 1.62566
d. kurtosis = 1.62566
eff. of variation = 5.26854
m = 126.559

Lognormal Probability Plot for Manganese



ummary Statistics for log(Nickel)

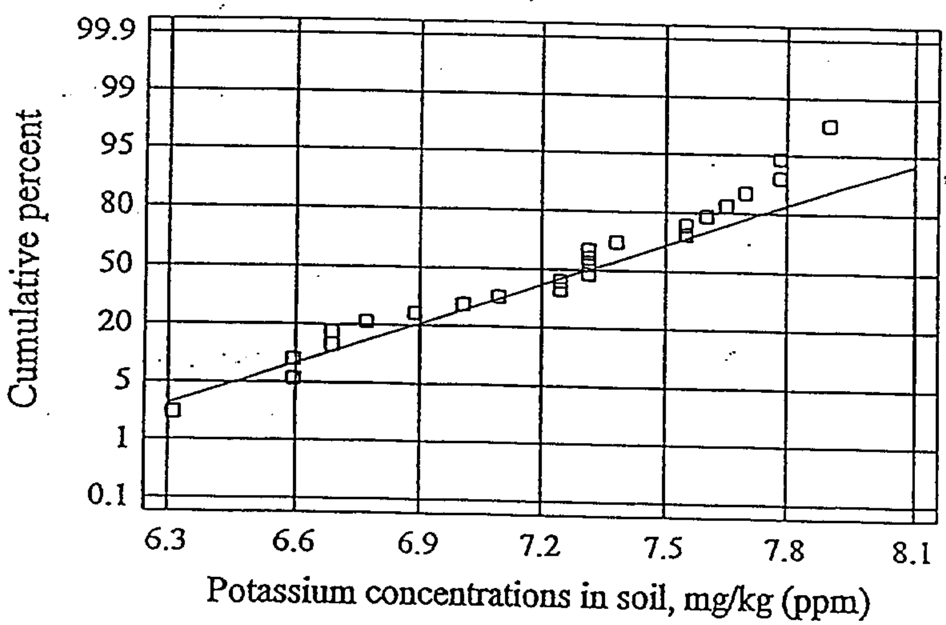
[illegible] = 23
[illegible]age = 1.78451
edian = 1.82455
ode =
eometric mean = 1.74596
riance = 0.1246
tandard deviation = 0.352987
tandard error = 0.0736029
nimum = 0.875469
ximum = 2.48491
nge = 1.60944
wer quartile = 1.58924
per quartile = 2.04122
terquartile range = 0.451985
ewness = -0.609856
nd. skewness = -1.19403
rtosis = 0.992502
nd. kurtosis = 0.971605
eff. of variation = 19.7806
n = 41.0438



ummary Statistics for log(Potassium)

ount = 24
verage = 7.21062
edian = 7.31322
ode = 7.31322
eometric mean = 7.20542
riance = 0.195599
andard deviation = 0.442265
andard error = 0.0902771
nimum = 6.30992
ximum = 7.90101
nge = 1.59109
wer quartile = 6.82802
per quartile = 7.57526
terquartile range = 0.747233
ewness = -0.373735
nd. skewness = -0.74747
rtosis = -0.83864
nd. kurtosis = -0.83864
eff. of variation = 6.12673
n = 173.247

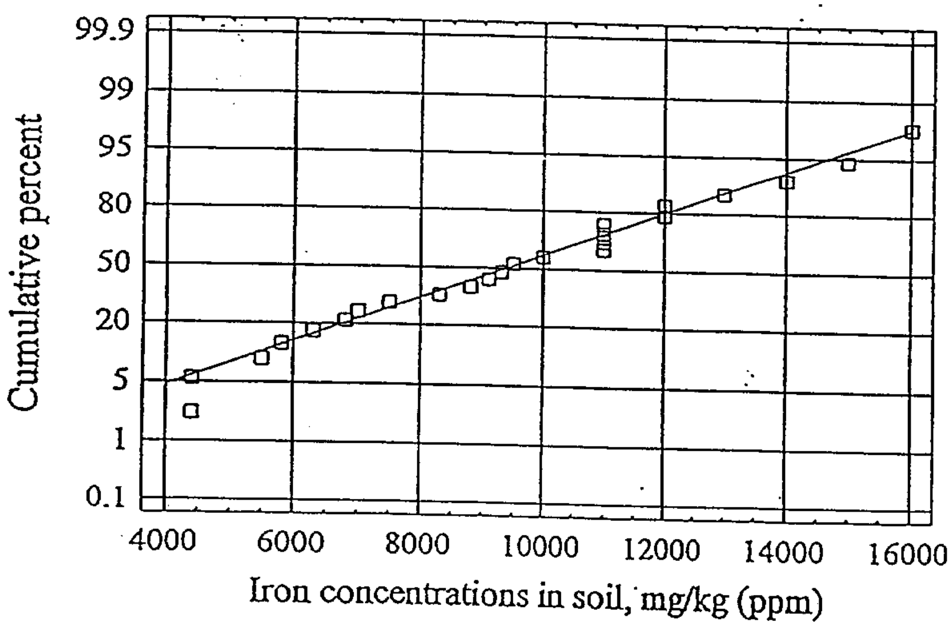
Lognormal Probability Plot for Potassium



umnary Statistics for Iron

= 24
age = 9529.17
edian = 9400.0
ode = 11000.0
eometric mean = 8977.5
ariance = 1.0363E7
tandard deviation = 3219.17
tandard error = 657.109
inimum = 4400.0
aximum = 16000.0
inge = 11600.0
ower quartile = 6900.0
pper quartile = 11500.0
iterquartile range = 4600.0
ewness = 0.20025
nd. skewness = 0.400499
irtosis = -0.620589
nd. kurtosis = -0.620589
eff. of variation = 33.7822
m = 228700.0

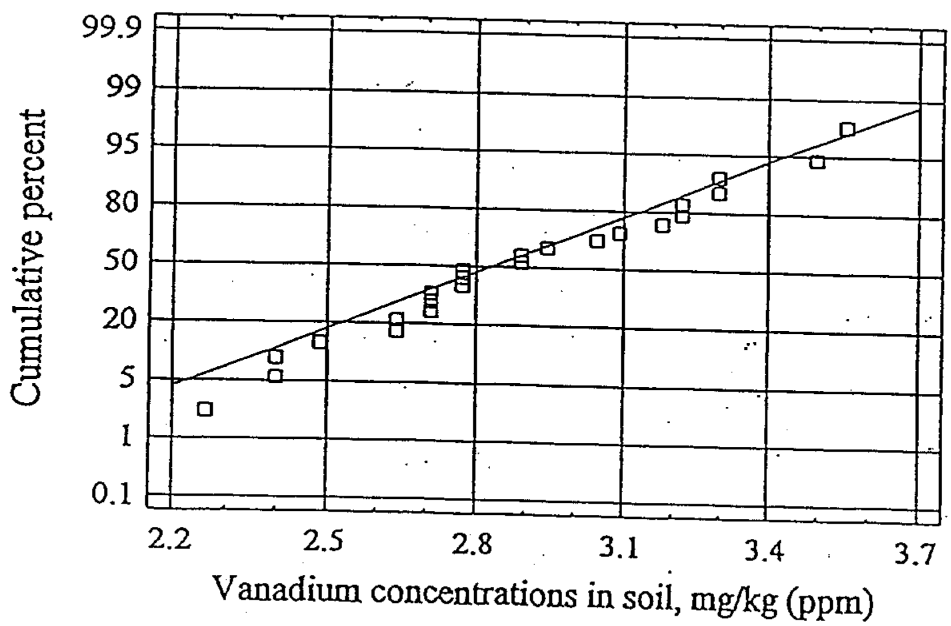
Normal Probability Plot for Iron



ummary Statistics for log(Vanadium)

```
ount = 24
verage = 2.89094
edian = 2.83148
ode =
eometric mean = 2.87064
ariance = 0.122444
tandard deviation = 0.34992
tandard error = 0.0714271
nimum = 2.26176
ximum = 3.55535
nge = 1.29358
wer quartile = 2.67355
per quartile = 3.19846
terquartile range = 0.524911
ewness = 0.158415
nd. skewness = 0.316831
rtosis = -0.688491
nd. kurtosis = -0.688491
eff. of variation = 12.104
m = 69.3826
```

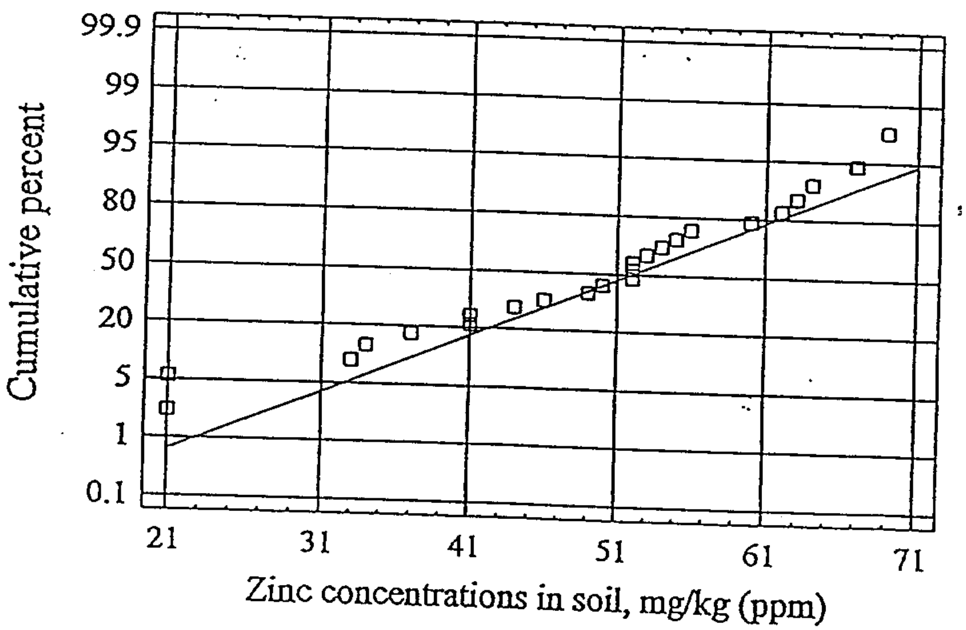
Lognormal Probability Plot for Vanadium



Summary Statistics for Zinc

```
  = 24
 ge = 49.0
ledian = 52.0
lode = 52.0
eometric mean = 46.9434
'ariance = 171.478
tandard deviation = 13.095
tandard error = 2.673
linimum = 21.0
laximum = 69.0
ange = 48.0
ower quartile = 41.0
pper quartile = 58.0
nterquartile range = 17.0
kewness = -0.633044
tnd. skewness = -1.26609
urtosis = -0.0224531
tnd. kurtosis = -0.0224531
oeff. of variation = 26.7244
um = 1176.0
```

Normal Probability Plot for Zinc



Local Background Soil Results

Sample Identifier	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury
Bkg-01-A	2700	6	2	110	ND	0.9	23000	3	3	6	5800	6	2100	190	ND
Bkg-01-B	4100	8	2	130	0.3	1.5	24000	5	4	7	8800	7	3100	230	ND
Bkg-02-A	2400	4	2	110	ND	0.8	35000	2	3	4	4400	3	2100	99	ND
Bkg-02-B	3400	7	2	130	ND	1	31000	3	3	6	6300	8	2700	210	ND
Bkg-03-A	4800	9	5	110	0.4	1.8	36000	6	5	9	11000	9	3700	210	ND
Bkg-03-B	6000	10	2	95	0.4	1.8	28000	7	5	9	11000	9	4400	250	ND
Bkg-04-A	4000	7	2	120	0.3	2.3	24000	9	4	13	9300	8	3000	190	ND
Bkg-04-B	3300	6	2	120	ND	1.4	24000	4	4	7	8300	6	2600	210	ND
Bkg-05-A	6400	13	6	210	0.5	1.8	78000	6	7	14	10000	16	5600	330	ND
Bkg-05-B	5500	10	6	140	0.5	1.7	33000	6	6	9	11000	11	3900	330	ND
Bkg-06-A	4500	9	6	150	0.3	1.5	46000	19	4	8	9100	8	3800	190	ND
Bkg-06-B	3800	8	2	150	0.3	1.1	51000	4	4	7	6800	7	3400	200	ND
Bkg-07-A	3100	6	2	95	0.3	1.1	34000.	4	4	6	7000	12	2600	170	ND
Bkg-07-B	3600	7	3	100	0.3	1.3	39000	4	4	6	7500	7	3000	180	ND
Bkg-08-A	2200	5	6	160	ND	0.6	54000	3	ND	4	4400	4	2600	110	ND
Bkg-08-B	3600	7	3	190	ND	1.6	60000	5	4	7	9500	6	4100	180	ND
Bkg-09-A	5900	11	6	210	0.4	1.7	49000	6	5	7	11000	8	5400	230	ND
Bkg-09-B	3400	7	3	210	0.3	0.9	82000	3	3	5	5500	6	3800	120	ND
Bkg-10-A	7500	11	2	140	0.3	2.3	42000	8	5	8	13000	12	3200	190	ND
Bkg-10-B	6600	11	6	150	0.3	2.6	35000	7	4	10	14000	11	3300	200	ND
Bkg-11-A	8300	13	2	200	0.4	2.2	43000	8	5	9	12000	18	3600	190	ND
Bkg-11-B	10000	16	2	200	0.5	2.4	40000	10	6	9	16000	20	4000	220	ND
Bkg-12-A	5600	11	2	200	0.3	2.2	55000	7	5	9	12000	9	4300	200	ND
Bkg-12-B	8600	14	6	290	0.4	2.6	47000	10	6	9	15000	13	5000	220	ND

Concentrations in mg/kg
Activities in pCi/g
Sample Identifier XX-XX-A - surface soil samples
Sample Identifier XX-XX-B - subsurface soil samples

Local Background Soil Results

Sample Identifier	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc	Tritium	Plutonium 239/24	Plutonium 238	Uranium-238	Uranium-235/236	Uranium-234
Bkg-01-A	4	1500	ND	ND	ND	ND	11	50						
Bkg-01-B	6	2000	ND	ND	ND	ND	16	63						
Bkg-02-A	2	730	ND	ND	ND	ND	9.6	41						
Bkg-02-B	5	1600	ND	ND	ND	ND	11	53						
Bkg-03-A	7	1500	ND	ND	ND	ND	19	56						
Bkg-03-B	9	1200	ND	ND	480	ND	15	62						
Bkg-04-A	12	1900	ND	1	ND	ND	18	55	<0.010	<0.009	<0.011	0.8	0.28	1
Bkg-04-B	5	1400	ND	ND	ND	ND	16	52	<0.022	<0.008	<0.009	0.3	0.02	0.3
Bkg-05-A	9	2700	ND	ND	ND	ND	22	37						
Bkg-05-B	8	1400	ND	ND	ND	ND	18	34						
Bkg-06-A	13	1500	ND	ND	ND	ND	16	52						
Bkg-06-B	6	800	ND	ND	420	ND	14	54						
Bkg-07-A	5	870	ND	ND	ND	ND	15	21						
Bkg-07-B	5	800	ND	ND	380	ND	15	21						
Bkg-08-A	3	730	ND	ND	ND	ND	12	33						
Bkg-08-B	5	980	ND	ND	430	ND	21	67						
Bkg-09-A	8	1100	ND	ND	280	ND	24	41						
Bkg-09-B	5	550	ND	ND	640	ND	14	44						
Bkg-10-A	6	2400	ND	ND	ND	ND	27	52						
Bkg-10-B	7	2200	ND	ND	ND	ND	27	49						
Bkg-11-A	7	2100	ND	ND	280	ND	25	60	<0.023	<0.007	<0.017		0.03	0.5
Bkg-11-B	8	2400	ND	ND	290	ND	35	64	<0.024	<0.012	<0.018		0.03	0.6
Bkg-12-A	6	1500	ND	ND	ND	ND	25	46	<0.084	<0.030	<0.017		0.17	0.8
Bkg-12-B	8	1900	ND	ND	620	ND	33	69	<0.023	0.035	0.038	0.6	0.33	0.9

Concentrations in mg/kg
Activities in pCi/g
Sample Identifier XX-XX-A - surface soil samples
Sample Identifier XX-XX-B - subsurface soil samples

Normal Parameters for Tijeras Arroyo Local Metal Background Data

Statistical Parameter	Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Vanadium	Zinc
median	4300	8.5	2	140	2	6	4.2	7.3	9400	7.9	200	6.2	17	52
geometric mean	4579.9	8.6	3	144	2	5	3.7	7.3	8977.5	8.5	195	6	18	47
maximum	10000	16	6	210	3	10	6.6	13	16000	20	330	12	35	69
minimum	2200	4.4	2	95	1	2	0.1	4.2	4400	3.2	99	2.4	9.6	21
arithmetic average	4970.8	9	3	149	2	5.5	4.2	7.5	9529.2	9.3	202	6.3	19	49
standard deviation	2095.4	3	2	40.5	1	2.3	1.3	2	3219.2	4.2	53.6	2.1	6.9	13
normal tolerance	2.309	2.3	2	2.33	2	2.3	2.3	2.3	2.309	2.3	2.31	2.3	2.3	2.3
UTL	4927.4	16	7	244	3	11	7.3	12	16962	19	326	11	35	79

Lognormal Parameters for Tijeras Arroyo Local Metal Background Data

Statistical Parameter	Aluminum	Antimony	Arsenic	Barium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Nickel	Vanadium	Zinc
arithmetic average	8.4294	2.2	1	4.97	0	1.6	1.3	2	9.1025	2.1	5.27	1.8	2.9	3.8
standard deviation	0.4126	0.3	1	0.27	0	0.5	0.8	0.3	0.3631	0.4	0.28	0.4	0.3	0.3
normal tolerance	2.309	2.3	2	2.33	2	2.3	2.3	2.3	2.309	2.3	2.31	2.3	2.3	2.3
UTL	9:3821	2.9	2	5.6	1	2.7	3.1	2.6	9.941	3.1	5.91	2.6	3.7	4.6
e^{UTL}	11874	19	10	271	4	14	21	14	20764	23	370	14	40	98

Insufficient data for mercury, selenium, silver, and thallium to calculate statistics
All concentrations in mg/kg

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Summary of Background Concentrations for Radionuclides in Soil

Analyte	Original Number of Samples	Number of Detects	Number of Rejected Samples	Distribution Type	Range (pCi/g)	n[a]	Geometric Mean (pCi/g)	Median (pCi/g)	95th Upper Tolerance Limit (pCi/g)	95th Percentile (pCi/g)
Bismuth-212	324	17	307	Nonparametric	0.414–2.7	17	1.1055	1.0	–	2.7
Bismuth-214	340	321	19	Nonparametric	0.27–1.4	321	0.648	0.6	–	0.8
Cesium-137	802	561	26	–	–	–	–	–	–	–
(Surface)	–	–	–	Nonparametric	0.004–10.1	604	0.200	0.2495	–	0.92
(Subsurface)	–	–	–	Unknown[c]	<detection limit (<0.0686)	172	<detection limit (<0.0686)	<detection limit (<0.0686)	–	<detection limit (<0.0686)
Cobalt-60	321	11	74	Unknown	<detection limit (<0.0418)	247	<detection limit (<0.0418)	<detection limit (<0.0418)		<detection limit (<0.0418)
Lead-210[b]	338	40	292	Nonparametric	0.3–12.0	46	2.26838	2.835	–	6.8
Lead-212[b]	323	233	90	Lognormal	0.1–1.4	233	0.49689	0.5	1.0795	–
Lead-214[b]	249	241	9	Lognormal	0.29–1.13	240	0.549	0.56	0.90	–
Potassium-40	722	720	4	Normal	0.192–31.0	718	15.889	16.4	25.34	–
Radium-224	24	24	0	Nonparametric	0.43–0.97	24	0.6747	0.655	–	0.568
Radium-226	368	53	314	Lognormal	0.5–2.09	54	0.713	0.590	1.94	–
Radium-228	24	24	0	Nonparametric	0.45–1.05	24	0.695	0.630	–	1.05
Radon	0	0	0	Unknown	–	0	–	–	–	–
Strontium-90	54	45	9	Nonparametric	0.032–1.85	45	0.2528	0.2883	–	0.766
Thorium-232	136	136	0	Lognormal	0.23–1.20	136	0.7971	0.810	1.258	–
Thorium-234	365	52	330	Lognormal	0.324–3.0	35	0.7796	0.71	2.89	–
Tritium	0	0	0	Unknown	–	0	–	–	–	–
Uranium-234	4	4	0	Nonparametric	0.8–1.0	4	0.897	0.9	–	1.0
Uranium-235	95	21	75	Nonparametric	0.05–0.18	20	0.1198	0.1235	–	0.168
Uranium-238	223	206	17	Nonparametric	0.0033–2.065	206	0.506	0.763	–	1.1

[a]Sample size.
[b]These constituents are not listed as COC in Table 2-2 for this media.
[c]Constituents of concern are of unknown distribution type because data are either below the limit of detection, unusable, or nonexistent.

(IT, 1994)